

THE SURVIVOR

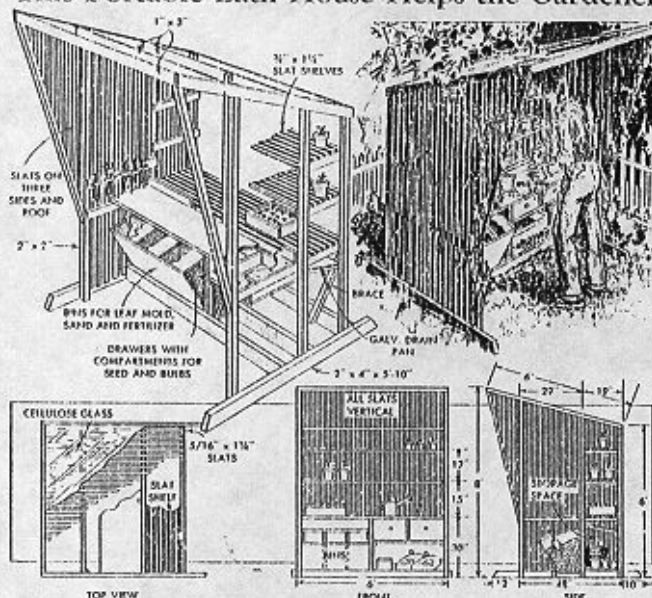
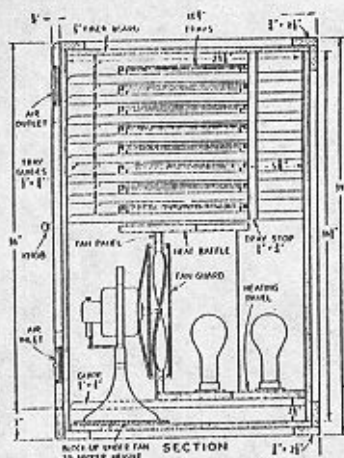
Volume 8

By Kurt Saxon

This Portable Lath House Helps the Gardener

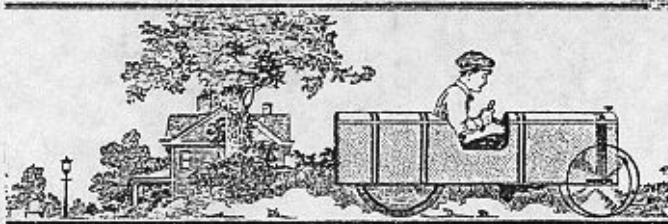
JUST A FEW OF THE
ARTICLES IN Vol. 8

SILK SCREEN
PRINTING
ARC WELDING
GENERAL METAL-
WORK
TAXIDERMY
ELECTROPLATING
HYDROPONICS
POTTER'S WHEEL
REPULSION COIL
GAMES
TOYS
CRAFTS
HOME BUSINESS
PLAYGROUND
EQUIPMENT
EDITORIALS
19th CENTURY
STORIES
HOBBIES
HOMW SCHOOLING
PROJECTS
FOOD DEHYDRATOR

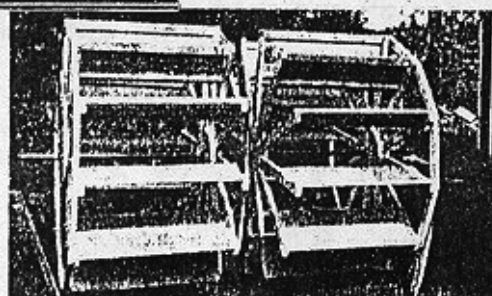


Removable tray on swing is convenient play surface, or baby's food can be served on it at mealtime

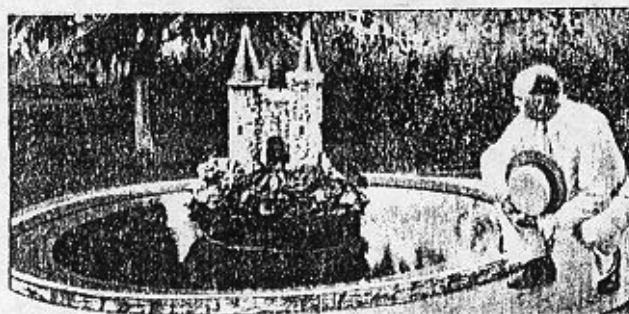
Nighttime Decoration in Room
Made With Luminous Paint



"Somebody has been at
my porridge!"



The wheel is built in two parts so that each half can pass through the cottage doorway for storage out of season.



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(870) 437-2999

FAX (870) 437-2973

Web site SURVIVALPLUS.COM

E-Mail cary@survivalplus.com

THE SURVIVOR

Volume 8

By Kurt Saxon

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PREPARE FOR THE WORST AND PROSPER BY Kurt Saxon

Too many people think that preparing for the collapse is a fool's game and an expensive one. Many are justified in thinking this way since survival hucksters are actively preying on those who are waking up to the true state of civilization.

The hucksters have put a price on survival, and a high one. According to them, you must be comparatively wealthy, and psychologically unfit to survive, being helpless and unable to do for yourself. But they will save you anyway, if you have the price. The greatest promoter of the survival of those hopelessly locked into the Establishment is the magazine, *American Survival Guide*. This is a publication whose main thrust is to cater to the fantasies of those who know things are getting worse but look for some kind of best case scenario wherein they can be safe. *ASG* is full of best case scenarios whereby one with talent, genius and education can manipulate what is left of any system into a cozy niche for himself. And of course, every reader believes he has a full measure of that talent, genius and education.

But first he must buy the "Survival" products which will keep him safe until the worst blows over. What that "worst" is, *ASG* seldom implies. The underlying message is that salvation comes through buying and that all inadequacies can be compensated for by cash.

I seem to remember a color ad on the back of an issue of *ASG*, or it might have been in *Mad Magazine*. Anyway, it pictured a man and woman and two kids in a personal survival shelter. They were surrounded by stocks of Mountain House Freeze Dried Foods, a generator and several guns, all expensive and most semi-automatic, a composite of *ASG* ads.

The unasked question posed by the ad was, why should these people survive? No one would want them dead, of course, but

what were their qualifications, when the ad showed them as unwilling to participate in the greatest adventure, the greatest opportunities facing the best of our species. Those who would lock themselves away and do nothing while most of their fellows perish, and then expect to come out and share what others have rebuilt, are naive to the point of insanity.

But this has been the fantasy promoted by *ASG* and nearly every other self-styled survival publication. And the severity of the situation and the demands made upon those who survive are not a matter of opinion.

I'll admit I was brought up in the old school that taught that one must live a good and purposeful life or burn. Others have been taught that they can live well, without struggle or purpose, and then be saved by \$Grace.

I sympathize with them but I can't encourage them. Nor can I tolerate the phonies who prey on their fantasies. Upbringing aside, logic proves me right. Consider; in 1850 the world's population finally reached one billion. Only 80 years later, in 1930, it doubled to two billion. Then, by 1975, it doubled again to four billion. In 1987 it grew to five billion. Now, in 1995, it is 5.7 billion.

The industries supporting the world's still growing population has caused global warming, the depletion of the ozone layer, deforestation, overwhelming pollution, etc. The unrestricted fertility of those born only to consume and pollute is a threat to all life on our planet.

Still, most of those who are not as yet directly affected, fail to see the logical outcome. They seem to believe that all this amounts to is some possible economic imbalances and social upheavals, only temporary of course. But those who can't see that all this adds up to global catastrophe in our lifetime are simply unable to reason.

ASG caters to this type. If *ASG*'s editor, Jim Benson and I were living in Bible times, before the Flood, I would be building an ark and Jim would be selling umbrellas.

The next few years will convince everyone that our species has out-bred the carrying capacity of our global environment and socioeconomic systems. Everyone will be affected and most will be threatened.

It is too late and the threat is too serious to tolerate those who would minimize the dangers to our very species. We are too close to the point of no return to trust our fates to hucksters of commercial "survival" products.

Your only chance to save yourself and your loved ones may be to learn the techniques for self-reliance practiced by your great-grandparents. If they were rural, or lived in a small town, you can be sure that they were little affected by any central government, especially if they didn't generate enough capitol to excite the tax man.

During the Great Depression, my grandfather had a farm, a country store, a sawmill, a grain mill and a blacksmith shop. Most of his dealings were by barter. For those in the community, he would saw five logs and keep the lumber from one. He would grind five bushels of grain and keep one-fifth of the flour.

Once a month he would load the truck with raw produce, drive to Harrison and trade it for whatever he needed for the store. His neighbors took whatever they needed from the store and often paid in labor or produce. There was little money but everyone was well-fed, well-clothed and the best of friends.

This kind of people will survive no matter what happens. They will survive because they can produce what their neighbors need. Not only will they fill a need in the community, but they will know how to raise and process most of their own food and barter the surplus.

None of this is beyond you. Your Disneyland for dummies is about to go over the edge. Face it! Then choose a trade and learn it. The SURVIVORS have so many cottage industries requiring little or no capitol that any number are within your reach.

Now back to the subject of preparing for

the worst and prospering. In light of the foregoing, and your own observations, you may feel the necessity to prepare for a future you dread. But look at it as an adventure or an opportunity or both.

You have a couple of years to prepare and both make and save money at the same time. Just realize at the outset that nothing in your survival program should be expensive; in fact, part of the game is learning to do better with less.

A subscriber recently called and told me of a friend who had been sold a year's supply of survival food. He had a wife and three children, one quite small. Thinking he had really gotten a bargain, the sucker shelled-out \$12,000 for a year's supply of "survival food" for a family of four. The crook then threw in a year's supply for the little one at no extra charge. My subscriber knew how to make his own survival food for his whole family for only a few hundred.

The difference between the two is that the sucker was fleeced through his dependence. He also had something that would teach him nothing, give him no skills, and might not even be fit to eat when the time came.

My subscriber, however, knows food, its basic preparation and its cheapness. He doesn't pay others three times its real price to process his family's food. He can eat better and save the difference to invest in what he needs to prepare for his family's future.

For instance, 50 pounds of hard red winter wheat from your local feed and seed store costs only \$7.00. Ground with the Corona Grain Mill, it translates to 100 pounds of the tastiest, most nutritious bread at only \$.20 a loaf. The extra is for yeast, eggs, etc.

The wheat can also be sprouted, dried and ground for a super food, plus any number of other clever, tasty and nutritious uses. You could almost live on it.

Whole corn costs only \$3.50 for 50 pounds. When ground, that is only \$.06 a pound, as opposed to \$.28 a pound for

degerminated store corn or \$.40 a pound for health food whole ground corn. Great for cornbread, cornmeal mush, corn pancakes, etc.

Then there are soybeans at \$.40 a pound when bought in bulk. Sprouted, that are six times their weight of delicious green vegetable for under \$.10 a pound. They turn into Tofu for \$.20 a pound as opposed to \$1.50 a pound in the store.

SURVIVOR Vol. 1 has all this and more, whereby, with the purchase of a hundred pounds each of soy beans, wheat, corn, rye and other beans, etc. you can provide your family with all their staples. Plus, you're not limited to a vegetarian diet. It is just that this program will eliminate three-fourths of your food bill.

But say the above is just too much of a first step. You want to save money on food and you want to stock up. But you don't want to spend thousands or bother with all that peasant labor. Fine, but a pity, as your reluctance to learn decreases your chances. However, you can stock up on food for about half its present cost, rather than three times its cost, as is the case with "survival foods".

Make a list of everything your family eats for a week. Then buy 10 cases of every non-perishable. It's a fact that cans, jars and plastic containers of food have a shelf-life of from three to five years. Even so, you are going to rotate, so even if it is a whole year's supply, no matter how long before you're going to need that year's supply, it will be relatively fresh.

Say you go to a discount store like Sam's. You get about 30% off. Even if you buy by the case from your local supermarket you will get 5 to 10% off since they won't have to handle the contents.

So you've got all this food, 10 cases each. Mark each batch of cases from 1 to 10. Start using case one. When you've finished it, buy another case and mark it 11 and start on case 2. You will find that by the time you are into case 3 or 4, prices will have risen. Even if

you have bought the food in bulk off the shelf, you will have saved money. Whether you buy grains, beans, etc., or cases of food or off the shelf by the basket, you will save money on what you'll have had to buy, no matter what.

Your next consideration is to choose a trade or skill which will fit you to supply a need. This could be the most important decision of your life, as a person's profession is his guarantee of security. If you have to depend on someone else for a livelihood, you will never have real peace of mind or a real life's purpose.

There must be some skill you've fantasized about which would give you a good living and respect. The SURVIVORS have hundreds. Toy making, gunsmithing, greenhouse operation, auto repair, carpentry, etc.

Choose a general area and take some night courses in shop, woodworking or whatever. This would keep you off the streets, wouldn't cost much, develop your talents, make friends and give you a lot of ego-satisfaction.

Unless you are in a rural area, now is the time to relocate. Pick your spot and get a realty guide for that area. Rural homes on an acre or more are going lower in price all the time. Study the realty guide and decide how big a place you want and will be able to afford. Thousands do it every month. Why shouldn't you?

When you have your house and ground, build a 20x30 foot greenhouse along its sunny side. Such a greenhouse will cost only \$400 to \$600, depending on whether you use roll plastic or corrugated fiberglass. Your savings on food alone will pay for the greenhouse. The kicker is, that even if you don't use it, it will pay for itself. It will keep the sun off that side of the house, keeping your home cool and saving on air conditioning bills. In winter it will make that side cozy warm and save on heating bills.

For starters, you can grow house plants to sell to stores for Christmas, etc. Go to a

store and look at them. They are always in demand and most women love such work. A modest profit, pleasant part-time work and you have paid a lot of bills. When you know more about growing you can expand to vegetables to use and sell for a real profit. All this with little cash outlay and good returns both in the short and the long run.

There are plenty of good books on greenhouses in your library. But first read "Greenhouse" beginning on page 271 in The SURVIVOR Vol. 1.

So far, as you have seen, preparing for the worst has not cost you more than you would have spent normally, and probably less. This is as it should be. So don't fall for any scare ads telling you to lay out a lot of money to survive.

Survivalism is more an attitude than an expense. Most arguments against it are just a cop-out to hide one's fear of challenge. It is so easy to go along with the system one is born into, even if that system is becoming repressive and even dangerous. It is hard for most people to leave the known and abandon the security they have depended on.

But all our ancestors did, at one time or another. And consider the Vietnamese over here and the Cubans. They all made a greater change than I am suggesting. What do they have that you don't?

One thing they have is persistence. They decided to do something, they planned it and they did it. They persisted until a large percentage of them are successful. But a person who can't persist, mainly because he isn't mentally weaned, might just as well go down with the rest of the herd. That's best for the species, after all.

Even so, as I have pointed out, the expense should be no consideration. And the rewards should more than compensate for any difficulties, even if a miraculous turnaround should take place. So the only question is, do you have the maturity and the character development to persist?

Ray Kroc, the founder of McDonald's wrote:

"Press on; nothing in the world can take the place of persistence.

"Talent will not; nothing is more common than unsuccessful men with talent.

"Genius will not; unrewarded genius is almost a proverb.

"Education will not; the world is full of educated derelicts.

"Persistence and determination alone are omnipotent."

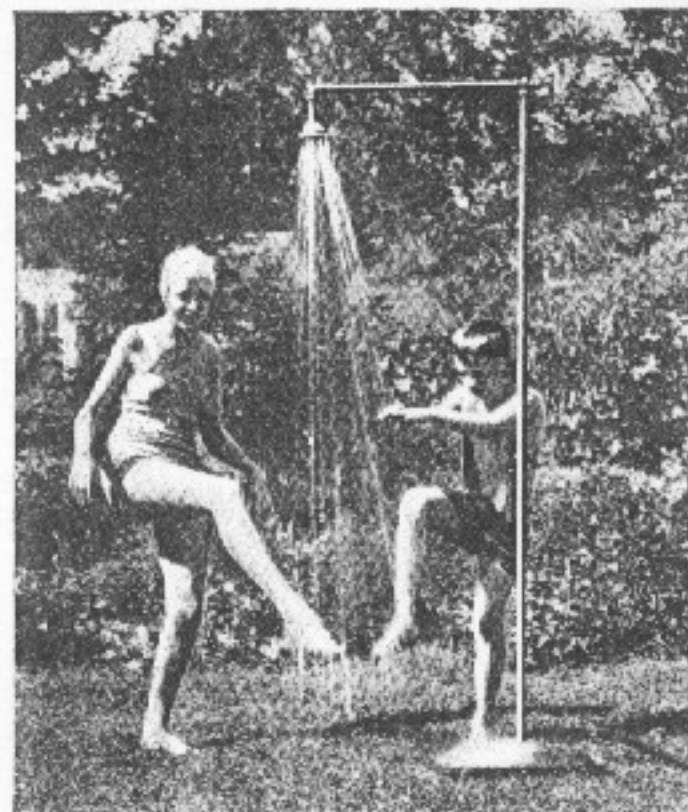
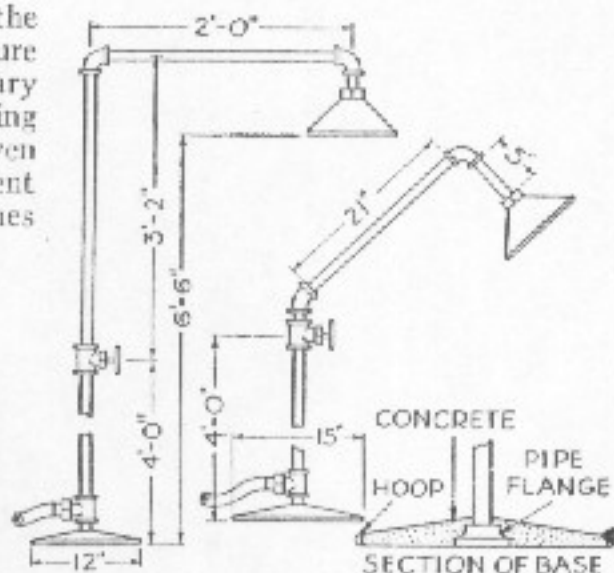
Memorize this and apply it and you will survive.

LAWN SHOWER KEEPS CHILDREN COOL

Popular Science Monthly July, 1933

A LAWN shower bath for children can be made at small expense as shown in the accompanying illustrations. This fixture may also be placed beside an ordinary bathtub and connected to the mixing faucet by a short hose, or it can even be used near a floor drain in the basement by connecting it to the hot and cold lines through a Y and a hose connection.

The base is a pipe flange cast in a circular concrete block or fastened to a flat board or an iron casting. The standard is made of $\frac{1}{2}$ -in. galvanized pipe and standard galvanized fittings. A regular shower head can be used or a cheap one purchased at the ten-cent store, or a hose sprinkler head will do very well for an outdoor shower. The cost of materials to make the one illustrated was \$1.94.—EARL D. HAY.



TEN EASILY MADE POPULAR SCIENCE MONTHLY Games... Toys... Novelties

December, 1935

By

DONALD W. CLARK

YOUR home workshop can help Santa Claus out a lot when it comes to making games, toys, and small novelties. The accompanying drawings offer ten suggestions, and you can use almost any of them as a starting point for additional designs of your own.

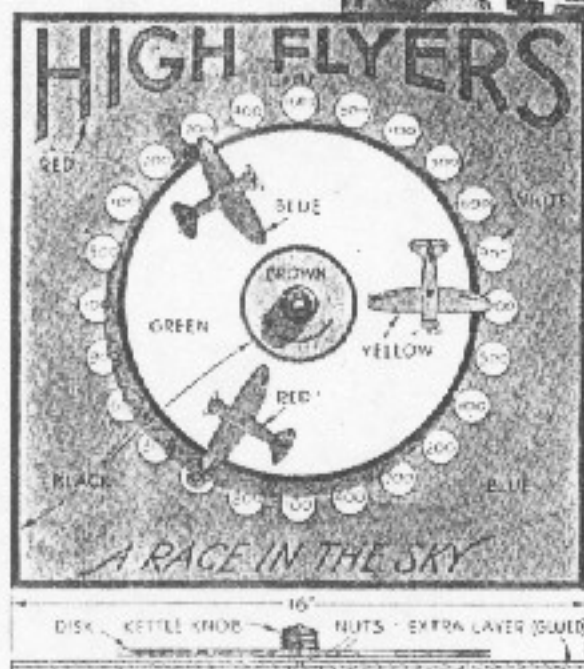
In the high flyers game, each player spins the disk once in turn and scores the number to which the wing tip of his plane points. If the tip points to the blue sky between the numbered circles, one additional spin is allowed. Score is kept, and the player whose plane reaches 5,000 or 10,000 ft. first is the winner. The game can be speeded up, if desired, by counting the numbers to which all three planes point after each spin.

Any number may play the rollo game. The player puts the block on the tail of the arrow with the beveled side up and gives it a slight push with one finger. If the block stops on a line, an extra play is allowed, but if it again stops on a line, no score is made.

The toy airplane is lifted bodily by the wire loop and held until the base spins all the way down. It is then set on the table, and the plane will start by itself and revolve a

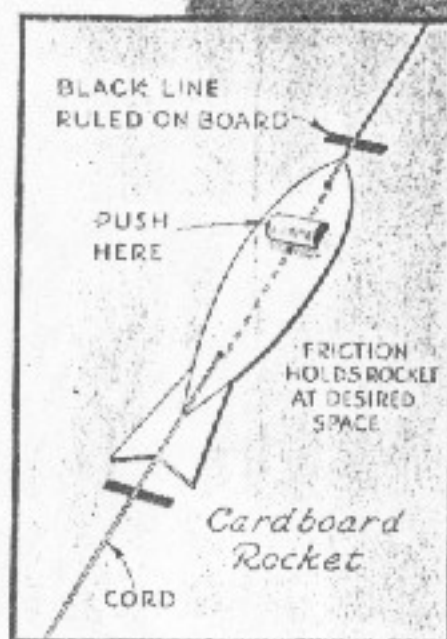
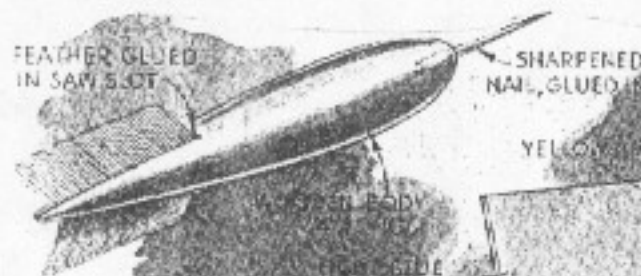
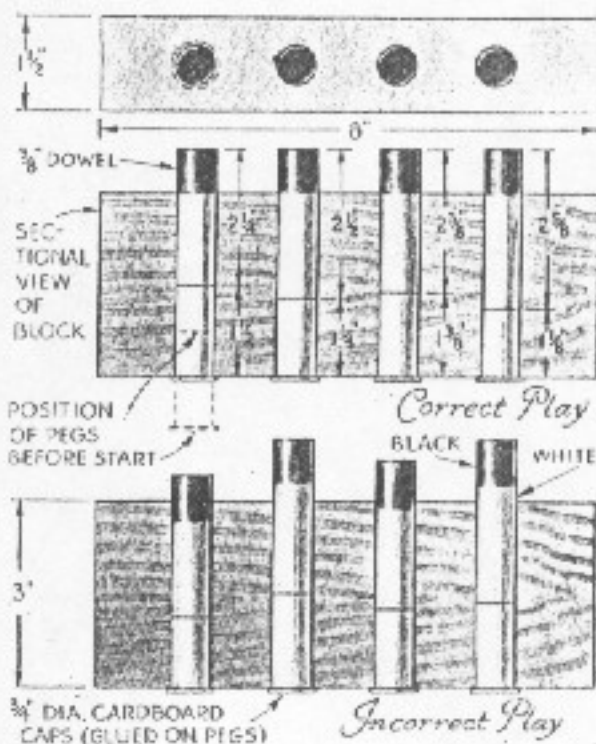
PLANES RACE FOR ALTITUDE ON GAME BOARD

The knob is spun as shown in the illustration at the right, and the central disk comes to rest with the airplane wings pointing to numbers as in the drawing below



CURIOUS PUZZLE MADE WITH PEGS

The push-peg puzzle shown below requires eight pegs of various lengths. The four pegs having black ends are first pushed in as far as they will go, then the others are inserted opposite

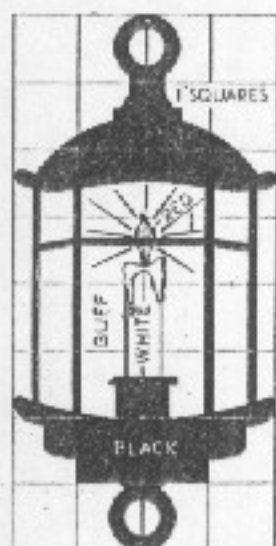


RANGE - 12 FT. USE THREE DARTS, A PIECE
ROCKETS RACE TO MOON IN EXCITING GAME
The contestants take turns throwing three darts—or vacuum-cup missiles if you object to darts. Move rocket up one if sun is hit; two if sun spot is hit; down one if earth is hit

number of times—fourteen in the case of the original model. Note that the wire is a single continuous length.

In the push-peg puzzle, the long pegs, which are painted black for $\frac{3}{4}$ in. at one end, are mixed up and pushed all the way into the holes from one side until the dark ends are flush with the block. The short pegs are then mixed up and pushed, one at a time, into the holes on the opposite side of the block as far as the cardboard caps will allow them to go. They will, of course, partly push out the longer blocks. If they happen to do so in such a way that only the black portion of each block projects, the puzzle is solved.

The rocket race is played by two players or two groups.

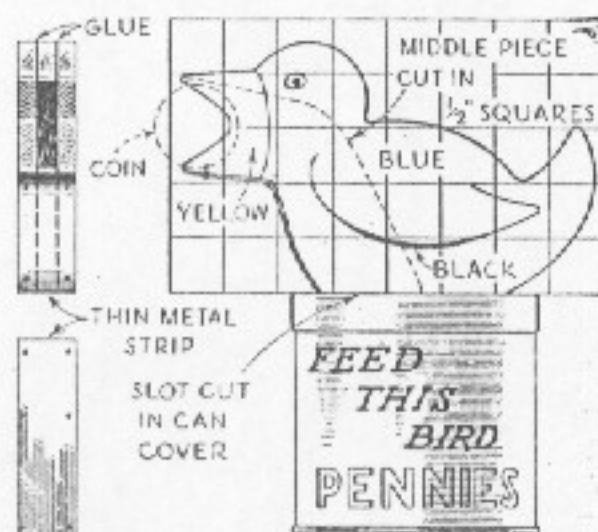
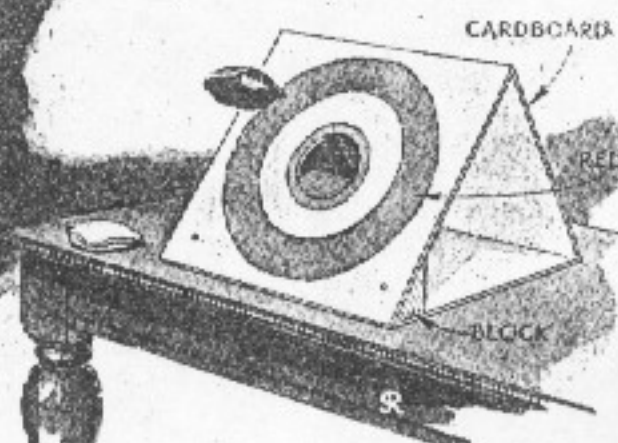


WALL LANTERN
A Christmas ornament painted on cardboard and cut out on the outline



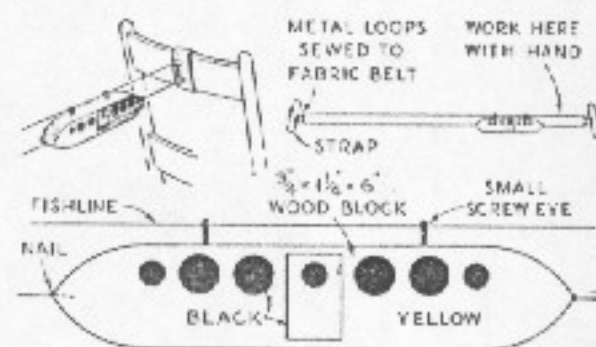
COLORED BEAN-BAG TARGET

One of the earliest sewing problems most girls are set is making a bean bag. They can have much more fun with bean bags if they or their fathers will make a neatly painted target with a hole in the center.



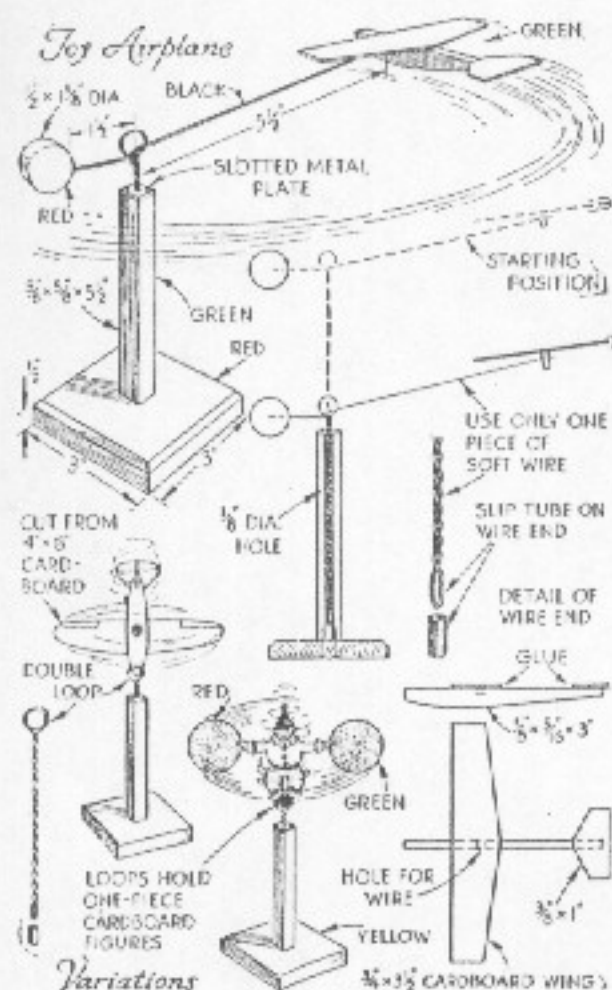
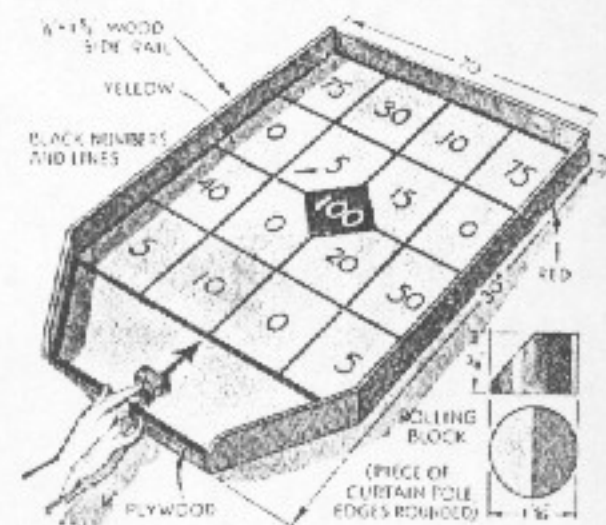
PENNY BANK SHAPED LIKE A BIRD

The bird is made from three pieces of wood, all jig-sawed at once. The central piece is about $\frac{1}{8}$ in. thick, but the outer ones may be a trifle thicker. Cut the middle piece as shown by the dotted line, assemble the three, and close the front of the slot with a strip of thin metal. Fasten the finished bird over a slot cut in the top of a tin can



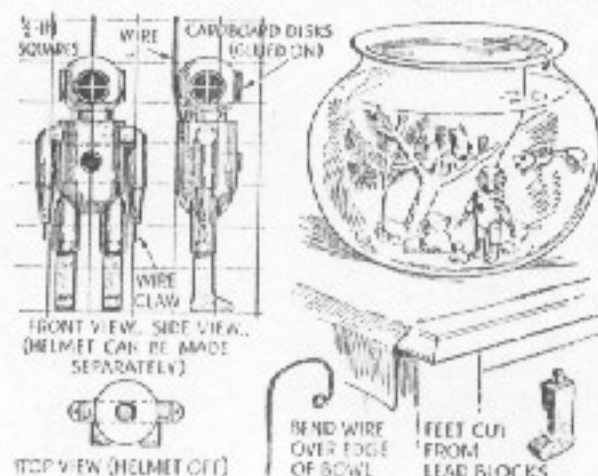
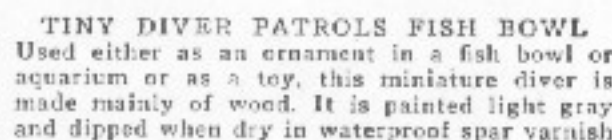
ROLLIO GAME KEEPS ONE GUESSING

What makes the game shown below interesting to players and spectators alike is the way the odd-shaped rolling block flops down the board



WHIRLING TOYS MOUNTED ON WIRE

Small cardboard airplanes and a large variety of other toy figures, such as a whirling clown, may be mounted on twisted wire so that they revolve in a realistic manner. The action is similar to that of the familiar spiral screw driver



Giant Repulsion Coil

GIANT HOME WORKSHOP MANUAL

1941



When the switch is thrown, an aluminum ring is shot into the air by the coil

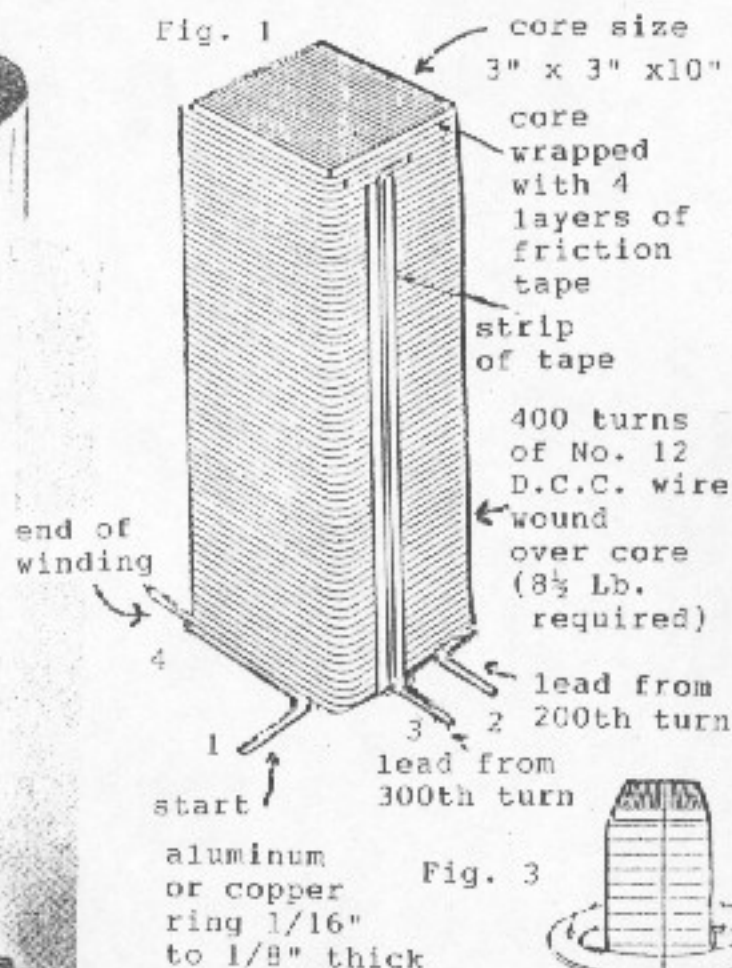


Fig. 2

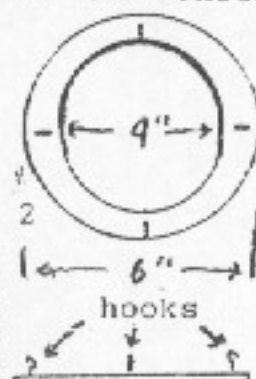
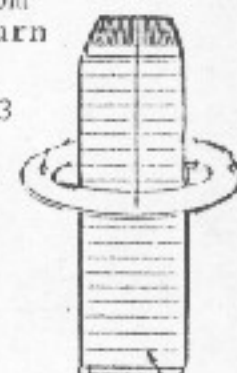


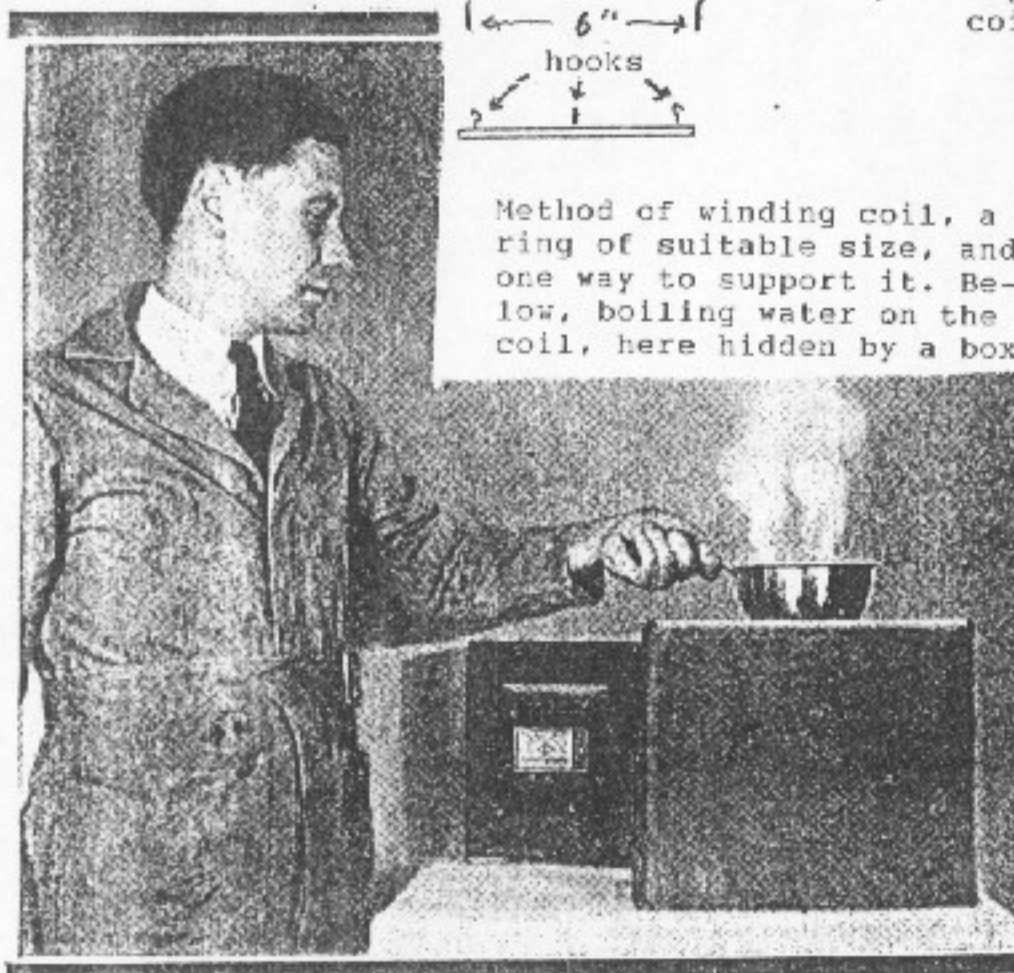
Fig. 3



taped coil

WITH this easily built repulsion coil, amazing electrical stunts can be performed. It is sure to prove popular at school science shows, magical performances, and the like. The coil can be used on 110- and 220-volt alternating current. It should never be connected to a direct-current line.

Large aluminum or copper rings may be shot into the air with considerable force, and plates of the same material may be made to float in air, apparently nullifying the force of gravity. Water may be brought to the boiling point and an egg may be fried in vessels held above the coil, all without the application of outside heat. In



Method of winding coil, a ring of suitable size, and one way to support it. Below, boiling water on the coil, here hidden by a box

MAKES METAL FLOAT MYSTERIOUSLY IN THE AIR AND FRIES EGGS OR BOILS WATER WITHOUT EXTERNAL HEAT

fact, the operator can hold his hand between the coil and the kettle or frying pan. Copper or aluminum pans are best; iron vessels may be used, but there is a tendency for them to be pulled down to the coil.

These mystifying stunts are made possible by utilizing the principle of induction. The repulsion coil acts as the primary of a transformer, and the metal plate, ring, or vessel serves as the secondary in which high currents are induced.

To build the repulsion coil, obtain sufficient old transformer laminations (approximately 22 lb.) to make a core 3" square and 10" long. If transformer laminations are not available, No. 24 or 26 stovepipe iron may be substituted, but each piece should be shellacked and allowed to dry before the core is assembled. Stack the core pieces into an even pile and bind them tightly with three layers of friction tape.

Wrap a layer of thin cardboard around the core and proceed with the winding, which consists of 400 turns (8½ lb.) of No. 12 double cotton-covered wire, with taps brought out from the 200th and 300th turns. The starting lead, with about 6" of wire protruding (marked No. 1 in Fig. 1) is secured by tying string around the core. Exactly 100 turns of wire should be wound in

each layer so that the taps for lead No. 2 and lead No. 3 may be made at the end of a layer. Where the connections are made for leads No. 2 and 3, the joints should be soldered and thoroughly taped.

Since the coil may sometimes be used on 220 volts, it is advisable to place a layer of thin cardboard between each layer of wire to prevent a possible short circuit. Also, cover lead No. 3 with a strip of tape, as shown in Fig. 1. When the coil is wound, apply a coat of shellac or insulation varnish and cover it with a layer of friction tape.

A suitable ring is shown in Fig. 2. Because of its large current-carrying capacity as compared to its weight, a ring made of ⅜" aluminum seems to give the best results. Either copper or aluminum of a different thickness may be used, but the ring must be in one piece.

To project the ring into the air, it should be placed a little above the center of the coil. This may be accomplished by placing hooks on the ring and tying pieces of thread between the hooks, as shown in Fig. 3. Another method, illustrated in one of the photographs, is to build a wood frame that fits over the coil and holds the ring in position.

If a box is placed over the coil, an aluminum or copper plate (containing at least 1 sq. ft. of metal) may be made to float above the box without any apparent cause. A kettle of water will quickly come to a boil when placed on the box over the coil. Flash-light bulbs with their terminals connected to a few turns of wire will light up brilliantly if brought near the box.

In all experiments where effects of repulsion are expected, like the projected ring and the floating plate, the metals used must be nonmagnetic such as aluminum or copper. When the ring is in place over the coil, a heavy current is induced in the ring as soon as the current is sent through the coil. Since the current flowing in the ring is opposite to that flowing in the repulsion coil, it will set up a heavy magnetic field, which tends to force the ring away from the coil. If the ring were iron or some other magnetic



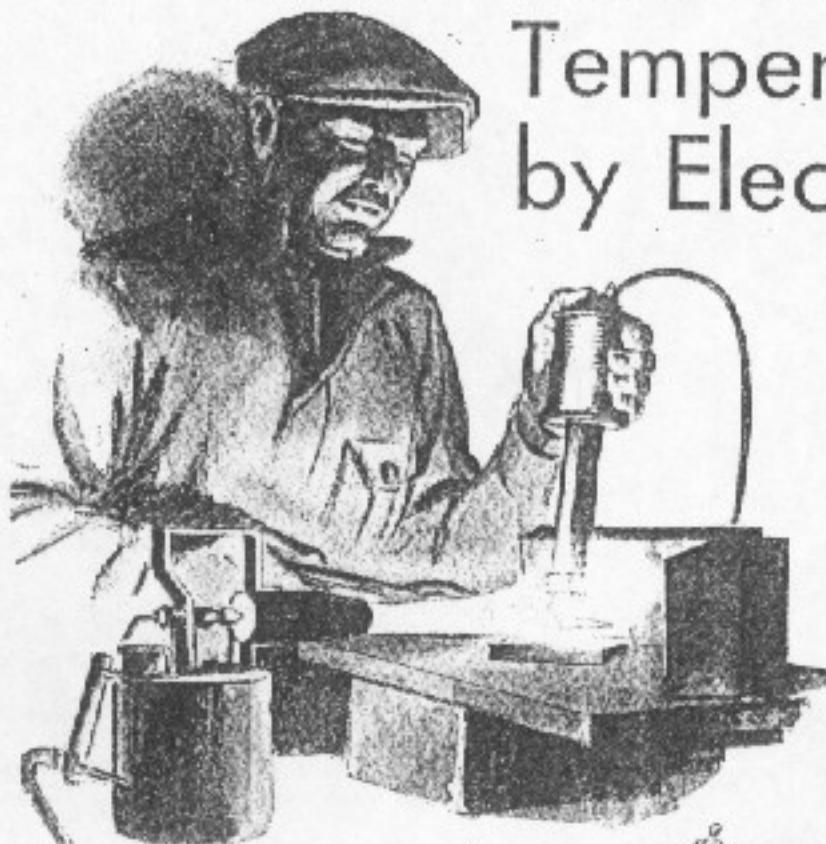
substance, the magnetic pull of the iron core would hold it down, counteracting the effect of the induced current.

Having several leads, the coil can be used on either 110- or 220-volt alternating current. When leads No. 1 and No. 4 are connected to the line, the current consump-

tion on 220 volts will be about 18 amperes, and on 110 volts, 9 amperes. Use these terminals when the current is to be left on, as with the floating plate and water-heating experiment. Use terminals Nos. 1 and 2, and Nos. 1 and 3, only for short periods, as in performing the projected-ring experiment.

POPULAR SCIENCE MONTHLY DECEMBER, 1937

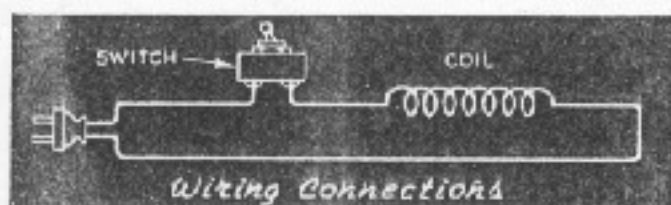
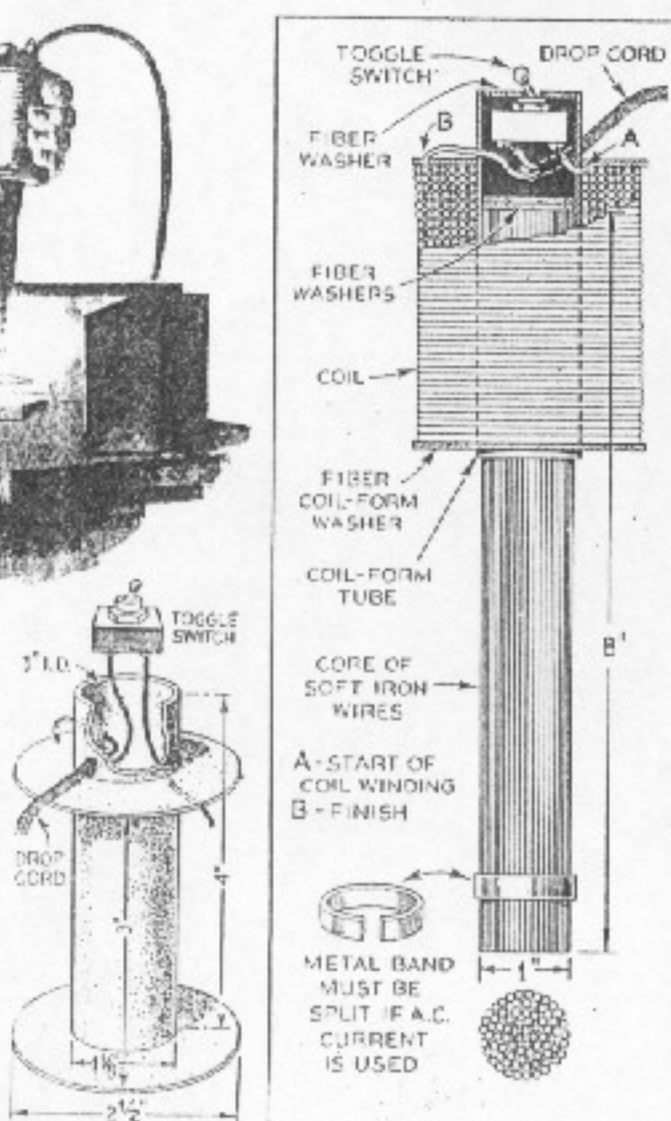
Tempering Aided by Electromagnet



THE correct temperature at which to quench steel during the tempering process may be determined easily with the aid of an electromagnet made as shown. The tool is brought slowly to a red heat and the end of the electromagnet is touched to the cutting edge. When the temperature has been raised to the point where no magnetic attraction is evident, the tool has reached the critical point and is quenched at once in clean, cold water. It is then reheated and drawn in the usual way.

This tester is much better than a permanent magnet for the purpose because it never loses its strength and, since it has a laminated core, transmits heat slowly. In fact, the end of the core may be placed directly in the fire for a long enough time to make the test. The tool also has other uses, such as removing iron or steel chips from drilled holes, retrieving nuts, washers, and other small parts that have fallen into inaccessible places, and holding small parts in position for assembly.

The core is merely a bundle of soft iron wires of small diameter, although thin strips of sheet iron may be used if preferred. The coil form is made as shown from fiber. The shell of a burned-out 100-ampere cartridge fuse is just

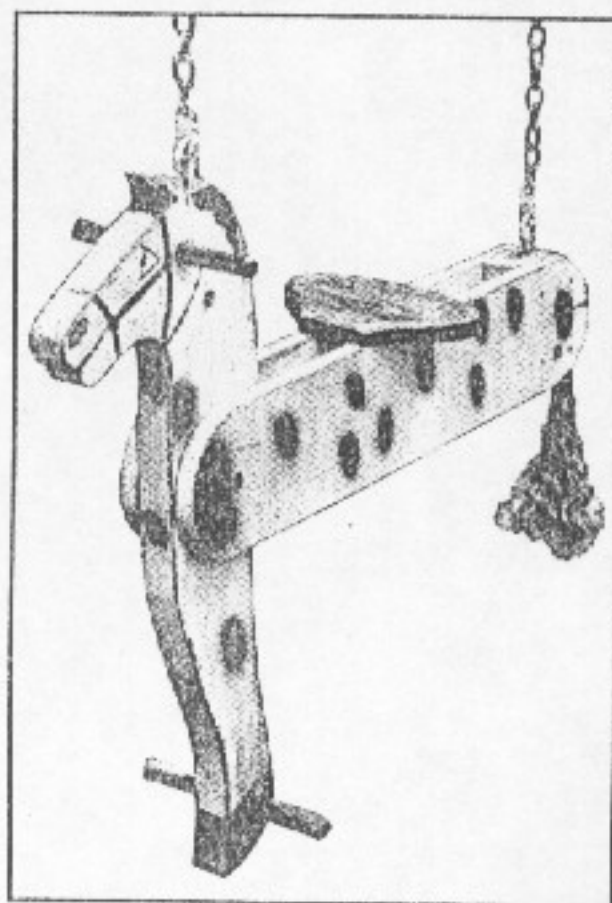


the right size for the tube. The coil-retaining washers are cut from 1/16-in. fiber board, pressed into position, and given several coats of shellac. A toggle switch is placed in the top of the tube and held with shims of sheet fiber, dipped in shellac. Before this is done, however, the coil is wound in even layers. For 110-volt alternating current, use 1 1/4 lb. single cotton-enamel wire, and for 6-volt battery operation, use 2 lb. of No. 16 single cotton-enamel wire.

After the connections have been made and the switch inserted, several fiber

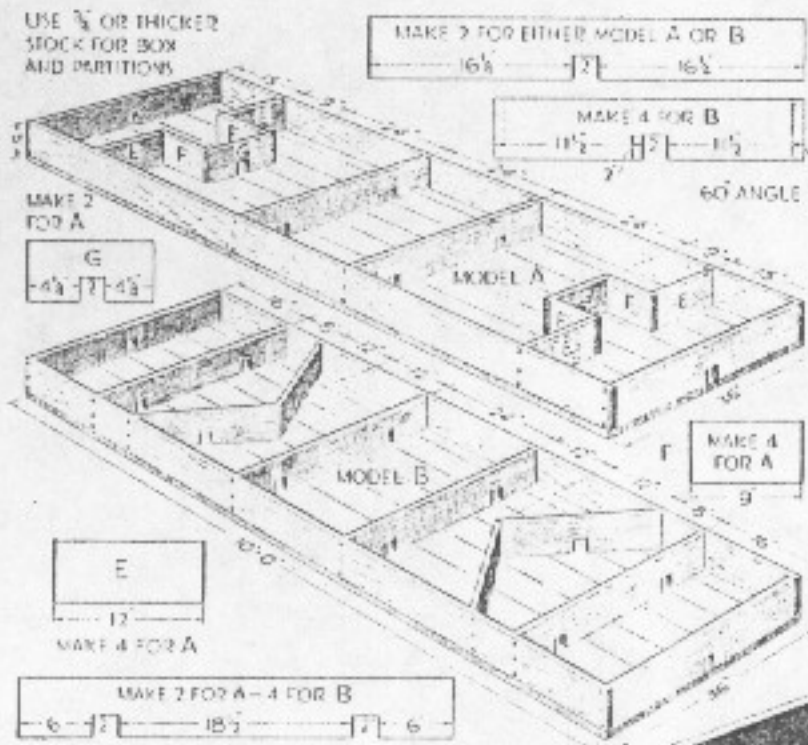
washers are pushed into the tube to protect the wires and the bottom of the switch, and the core of soft iron wires is then forced into the tube. A metal band holds the wires together near the end, and it must be split as indicated if alternating current from a light socket is used.—W. C. CHENEY.

HERE'S A HORSE

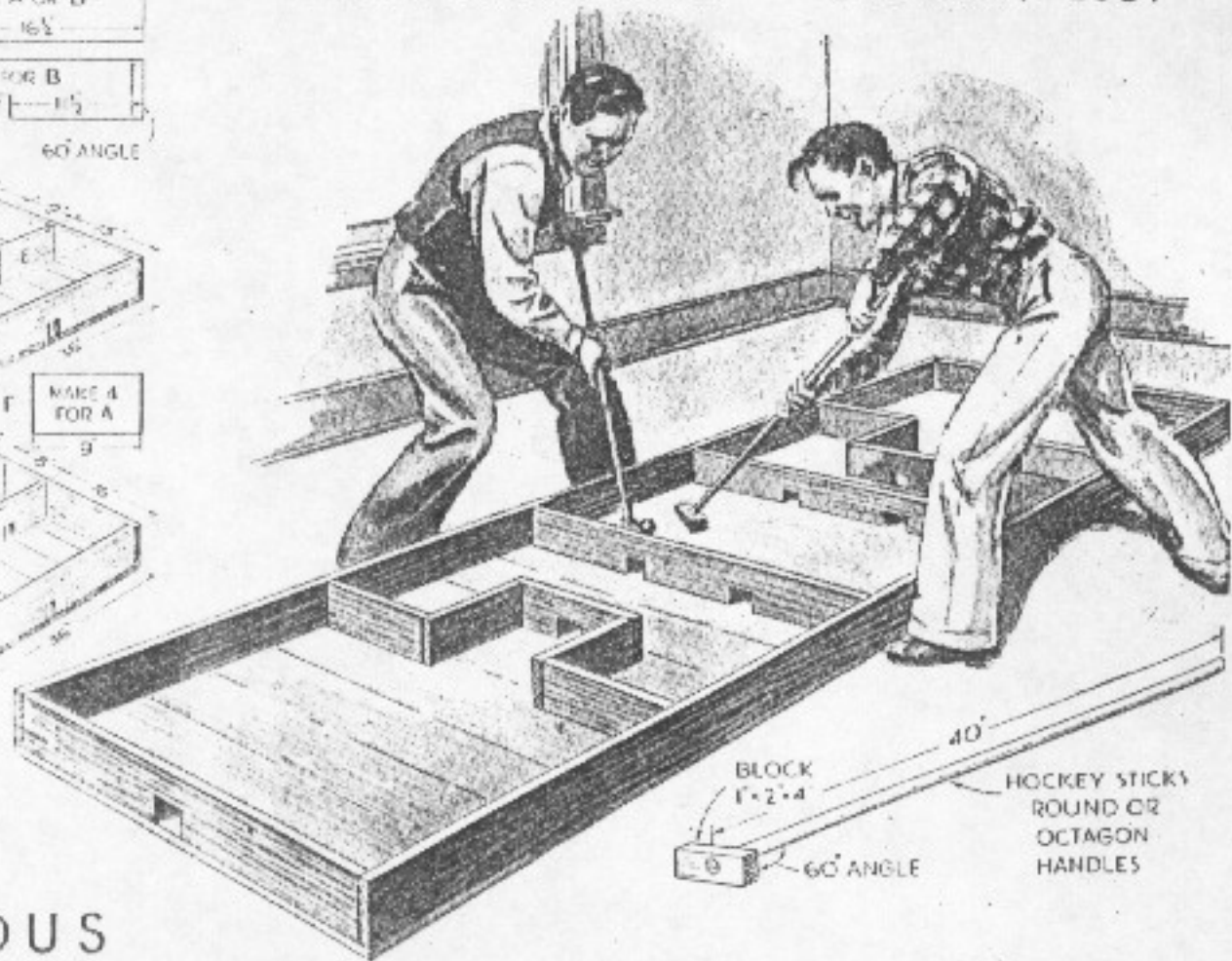


for hobby riders

● You'll ride to high favor with some lucky youngster when your tools have made and hung this Pine Pony swing. For children love this hobby horse who can follow his nose as easily as he can his heppen tail.



The object of the game is to drive the ball through the various holes and out of one end or the other. Either layout may be used



FAST AND FURIOUS

Hockey Game Played in Long Wooden Box

AN EXCITING substitute for hockey can be made as shown from old lumber of any kind strong enough to stand the severe pounding. Two or four players may take part, and the game is equally well suited for indoor use in inclement weather or outdoor use at camps or playgrounds or in any back yard.

The dimensions may be changed for the most part so as to suit the material at hand, though the width should not be more than 3 ft. The longer the game box, the more lively the scrimmage. If grown men are to play the game, the partitions will have to be made from 2-in. thick stock.

A broom handle makes a good stick, with a block of maple or oak for the head. The angle for the head is usually from 45 to 60 deg. A hole is bored in the head, and the handle is glued on very tightly.

The hockey ball should be about the size of a golf ball; in fact, a golf ball may be used, though something harder is to be preferred because a golf ball is inclined to bounce too freely. A small iron ball is better.

After the ball has been placed in the center of the middle compartment, the contestants start with "hockey one, hockey two, hockey three, play!" They tap their sticks together between each statement. At the third tap, the ball is in play, and the fun begins. The object is to take the ball as quickly as possible

out through the small holes to the goal.

Only a few rules are needed. Holes should not be blocked with the stick, and the ball must not be held tightly in the corners. If the ball is knocked out of the box, it should go back in play at the point where it left the playing

field, and the same starting process is used as at the beginning of the game. Players should not step into the box, but should stand on the floor or ground outside at all times. If the game is found too strenuous for two contestants, four can play.—R. H.

Popular Science July, 1945



Pencil Clip Used to Paint Stripe

YOU can do a neat paint-stripping job with an ordinary camel's-hair brush such as used by artists if a pencil clip is slipped over the ferrule and clamped into the position shown at the left. The ball of the clip will serve as a guide, keeping the brush tip from dragging heavily across the work and making the stripe uneven. Use pliers in order to crimp the clip on.—SIGMUND SAMETIL.



Now Anyone Can Try **TANK FARMING** *on a Small Scale*

GIANT HOME WORKSHOP MANUAL
1941

YOU may be one of the many who have become interested in soilless culture, but would like to try it on a very small scale at first. The apparatus illustrated fills just such a need. It is an adaptation of standard laboratory practice, using the drip method of Dr. John W. Shive. It can be used in a hothouse or outdoors through the summer, and not only one plant, but a whole battery of growing jars may be fed from a single supply bottle.

In working the glass tubing, hold it about 12" above a gas flame till the glass heats up, then lower it gradually into the direct flame. First a bend is made in one end, but allow enough room at the short end to hold on to it while the glass gets hot enough to bend. Cut off the short end so that it will correspond with the drawing. To cut glass tubing, make a notch with a sharp file at the point desired and snap like a twig. Cut the long end to leave 6" of straight tubing.

Hold the remaining piece of tubing at each end and heat the middle. When it begins to glow, pull each end, and the center will draw down. Continue pulling until there is only a threadlike piece of glass joining the two halves, then separate with a quick jerk. Wave the two pieces about until they cool. Break or grind off the pointed end of one of the pieces until one drop of water a minute will drip out of it when it is fitted to the siphon piece with the rubber hose. Prop the tube on rests as shown.

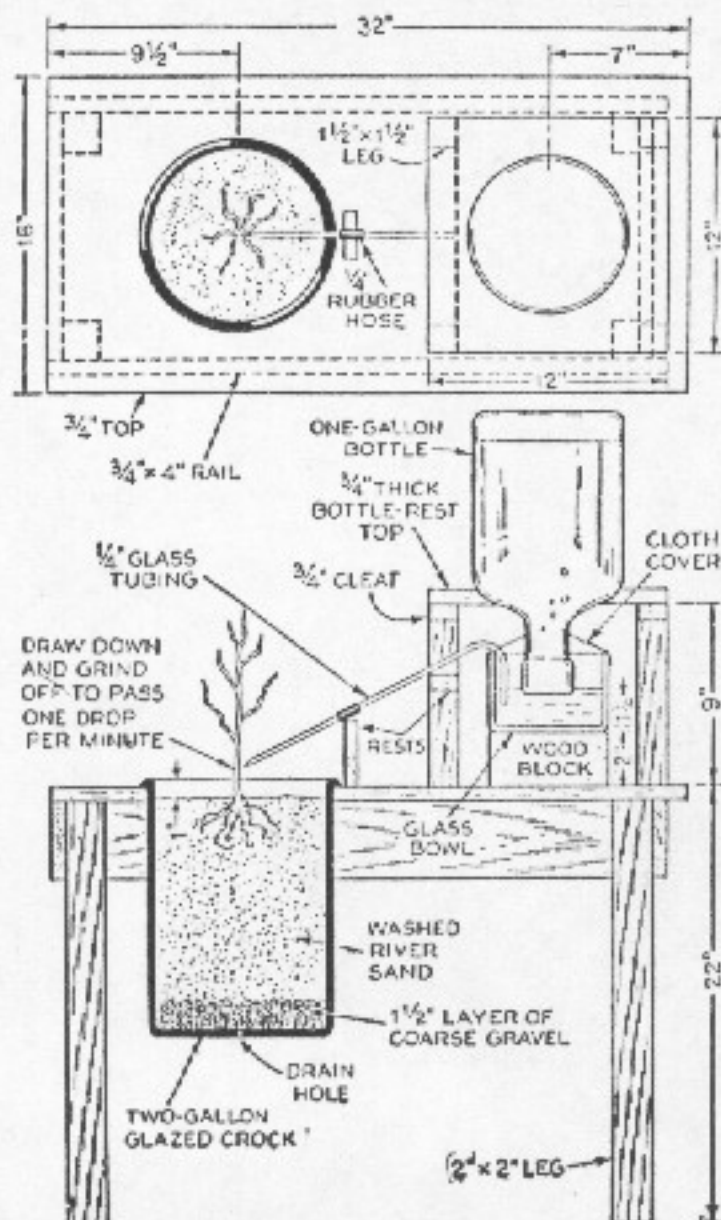
Drill or punch a drain hole in the center of the bottom of the crock. Put in about a 1½" layer of pebbles or coarse river gravel and fill to within 1" of the top with washed river sand. Moisten the sand and make a hole with the index finger in the center. Wash earth from the roots of the plantlet to be used and set it into the hole. Pack the sand gently around the stem.

The following solution is a general-pur-

pose one and will give average results with tomatoes, squash, cucumbers, and most flowers: 3 teaspoons epsom salts; 1 teaspoon muriate of potash; 2 teaspoons superphosphate; 1 teaspoon sodium nitrate. Use salts of the commercial grade sold for fertilizers (not chemically pure). Dissolve each thoroughly in a separate pint of water and siphon off the clear solution. Pour the clear solution from all four into a 5-gal. bottle.

Now measure out $\frac{1}{4}$ teaspoon manganese sulphate, $\frac{1}{4}$ teaspoon zinc sulphate, $\frac{1}{2}$ teaspoon iron sulphate, and $\frac{1}{4}$ teaspoon boric-acid powder. Dissolve all four in a pint of water. Add 1 teaspoon of this solution to the first solution and fill up the bottle with enough water to make 5-gal. Keep this bottle corked.

Fill the 1-gal. bottle from the solution in the 5-gal. container, put in a cork lightly, invert, and set in the bottle rest, pulling out the cork just before the neck reaches the bowl. One gallon will last about four weeks. When it has been used up, wash out with fresh water both the gallon bottle and the bowl, and refill the bottle. A cloth cover should be tied around the neck of the 1-gal. bottle to keep insects and dirt out of the bowl. About every ten days, 1 gal. of fresh water should be passed through the crock to wash out any accumulation of salts, or the plant will not thrive. If the sand gets too dry, the plant may be sprinkled with water without any detrimental effects.



POPULAR SCIENCE MONTHLY June, 1935

CARDS AID IN PERSPECTIVE DRAWING

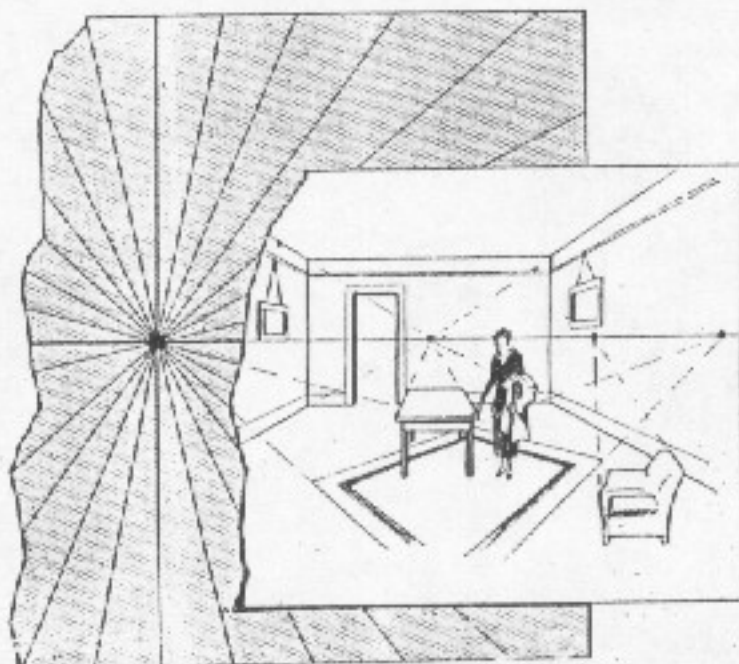
DRAFTSMEN, cartoonists, illustrators, and layout men, who daily encounter the problem of determining actual perspective without loss of time, can save much work by making a series of cards similar to the one illustrated. The cards vary in widths according to each individual's work. Tracing paper bearing the drawing is then merely laid upon the card selected, and the perspective of each object determined by following the lines.

The heavy line running through the center is the horizon. Various vanishing points, their positions depending upon the arrangement of figures in the drawing, can be easily ascertained by shifting the tracing along the horizon and marking off the vanishing points with a pencil.

The author has found it advisable to coat each card with a heavy spraying of artist's fixative. This protects the cards from damage.

The value of this idea is at-

tested by the fact that it has long been used by Robert Blickenderfer, an artist on the "New York Sun."—JOSEPH CREAMER.



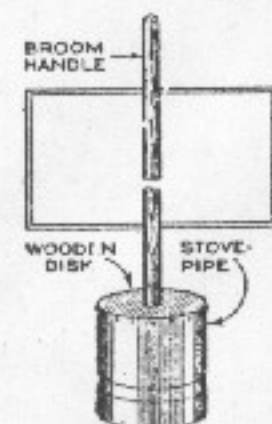
When the drawing has been roughly sketched on tracing paper, it is laid on a card for using the perspective

Cutter for Strawberry Runners

Popular Mechanics, 1925

Strawberry plants send out runners, that, unless kept cut off, permit the plants to spread to such an extent that they cannot easily be cultivated. This and other reasons make it necessary to keep the runners cut short, and the drawing shows a tool that eliminates this back-breaking labor of the strawberry grower. As shown in the sketch, a thick wooden disk is attached to the end of a wooden handle.

A piece of stovepipe is nailed to the disk and forms the cutter, the edge of which may be filed to make it sharper. In use, the cutter is merely placed over the plant and pressure applied to the handle, severing any runners longer than the radius of the hollow cylindrical cutter.

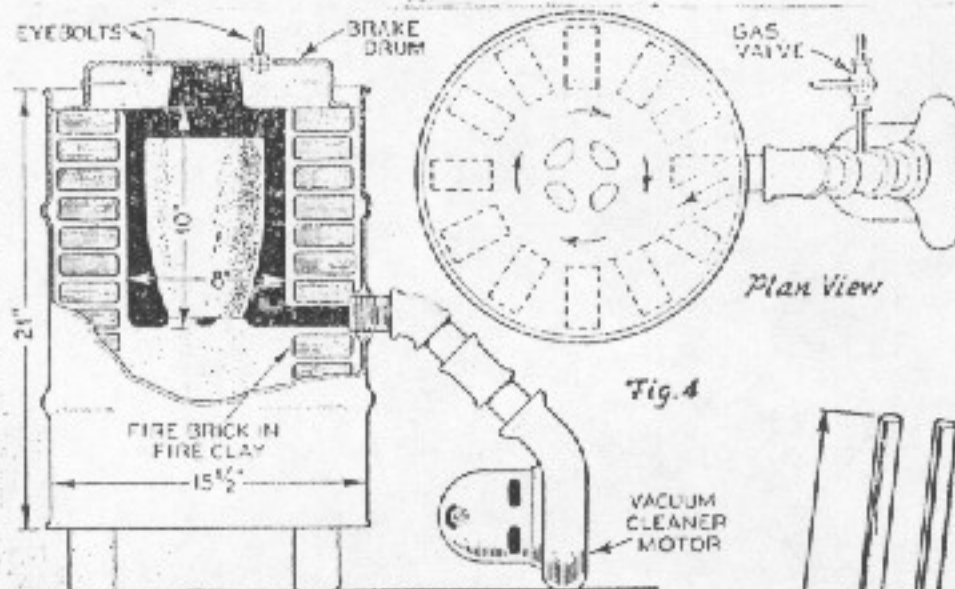


The equipment shown below will make the home mechanic independent of foundries for castings in the softer metals. Plans for a compact molding bench and two types of molding flasks appear on the following page.

POPULAR SCIENCE DECEMBER, 1938

SMALL FOUNDRY

for casting the softer metals



How the furnace is made. Left, lifting the crucible, which heats a glowing red in less than five minutes

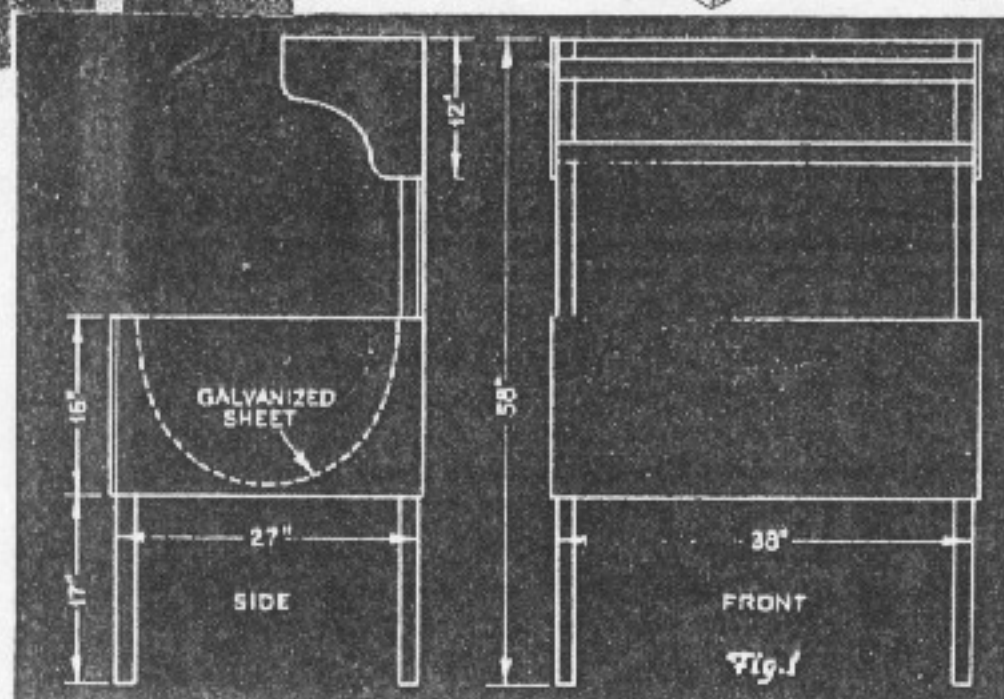
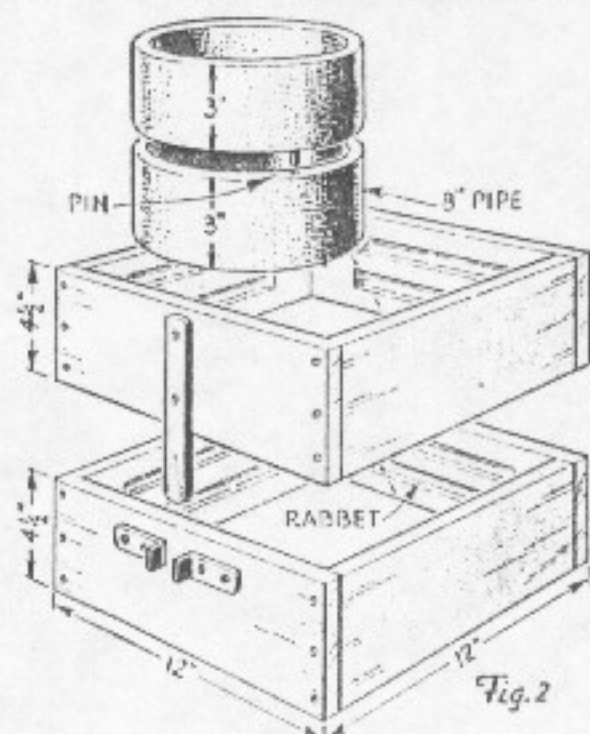
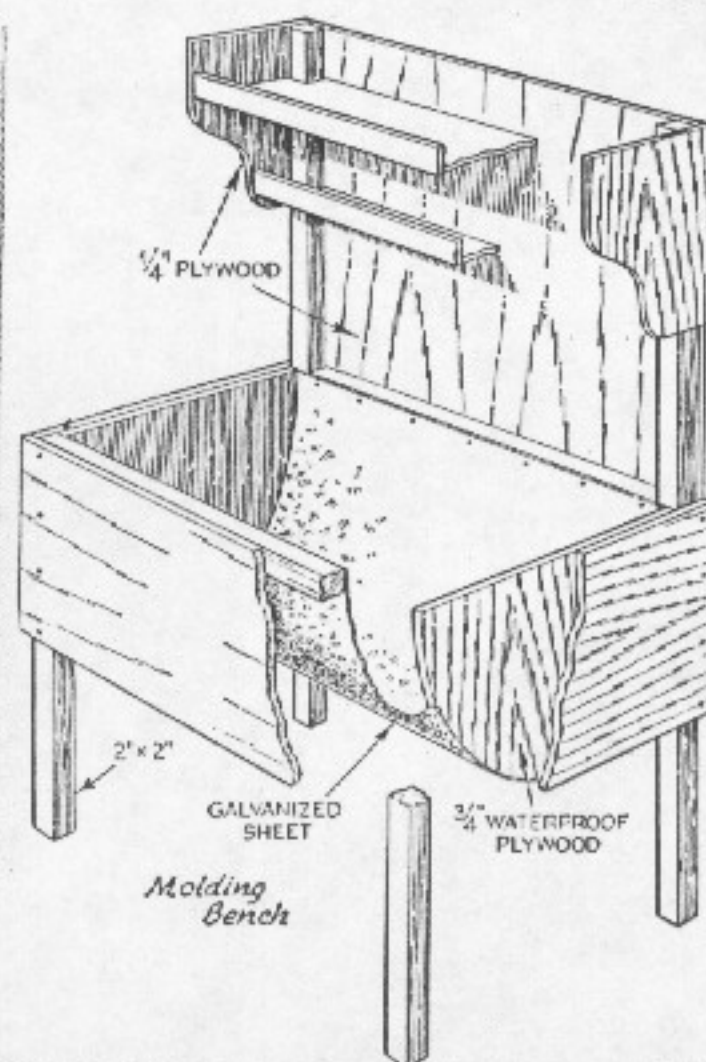
FOUNDRY equipment for casting aluminum, brass, and various soft alloys in the small shop or home workshop can be made for a comparatively small outlay as shown in the illustrations on this and the following page.

The molding bench (Fig. 1 on the next page) has a sand-box consisting of special waterproof plywood ends and a curved sheet of galvanized iron. The plywood is of the so-called "super-hard" variety, but if no material of this type is available locally, solid wood ends faced with galvanized iron on the inside may be used.

Flasks can be constructed either of wood or sections of large iron pipe (Fig. 2). Two pins are set into the iron flask to insure alignment, while steel brackets serve this



The crucible tongs. Left, the furnace cover is made from an old brake drum



Drawings of the molding bench with principal dimensions; sketch of the bench; a photo of it in use; and, left, two molding flasks

purpose on a wooden flask. Note the grooves on the inside faces of the wooden flask to prevent sand from falling out.

Tongs for lifting the crucible out of the furnace are shown in Fig. 3. They are used as illustrated at the beginning of the article. The furnace itself, Fig. 4, is made from a small oil drum and a discarded vacuum-cleaner motor and fan. The head of the drum is cut out with a chisel, which is not an especially tedious job. The motor is connected with pipe fittings, and the drum thickly lined with fire clay over fire bricks set radially as indicated.

Note that the flue from the blower comes

into the chamber at an angle, causing the flame to whirl around the crucible. Four small fire-clay bosses are made in the bottom of the chamber to permit heat to flow underneath the crucible. The lid is simply a brake drum packed with fire clay, which is held in place by nails inserted in the rim. The opening of the drum is formed by a slightly tapered sheet-metal cone, and the melting chamber in the drum is formed with the aid of a sheet-metal wall.

The original, built by a Pasadena, Calif., home workshop enthusiast, has produced a number of clean-cut castings, and is adapted to a large range of work.

Simplest of all designs for a

Boy's Auto

POPULAR SCIENCE MONTHLY September, 1933

BY
H. SIBLEY

Driven by a two-cycle, half-horsepower stationary engine, this foolproof and inexpensive little car travels 17 miles an hour

HERE is about the simplest little power wagon a boy can make—at least the simplest that will give satisfactory service. It is adapted to any of the small air-cooled engines of from half a horsepower up to three. There is no gearing and no clutch; the drive is direct to one wheel by V-belt, and to start the motor the passenger simply gives a shove and hops aboard.

As shown in the drawings, the wagon is equipped with a special flywheel brake and ignition cut-out, as well as a rear wheel brake, but both of these can be dispensed with if used where there is no traffic, for by stopping the engine it serves as a brake. The wagon can be further simplified by leaving off the steering gear entirely and using ropes to the front axle.

In the original wagon a standard half-horsepower utility motor is used, but a washing machine engine, model airplane engine, or bicycle motor can be utilized by fitting it with the proper pulley.

The wheels illustrated are standard toy automobile wheels with real balloon tires 2.5 by 12.75 in. Ordinary coaster wagon wheels will serve the purpose, although they will not give nearly as comfortable riding. Bicycle wheels are not at all satisfactory, even the small sizes, because they will not take a large enough axle and are not built for side-sway, which is inevitable in a four-wheel vehicle.

General dimensions are given in the drawings on this page. Note the low center of gravity and very short wheel base, which make it possible to maneuver easily in limited space. The passenger sits at one side to balance the engine on the other, and this also allows him to make adjustments while running. The flywheel guard, shown in the drawings on page 76, removes all hazard of getting clothes or fingers caught in the machinery.

The chassis frame is made up of 2 by 2 in. longirons with a cross member at the rear of the same stock and a 2 by 3 in. piece at the front for carrying the kingbolt. A 7/8-in. board is set crosswise to support the motor and passenger's seat. Note that this board is fastened to the frame with screws and has cleats underneath. When the new belt becomes



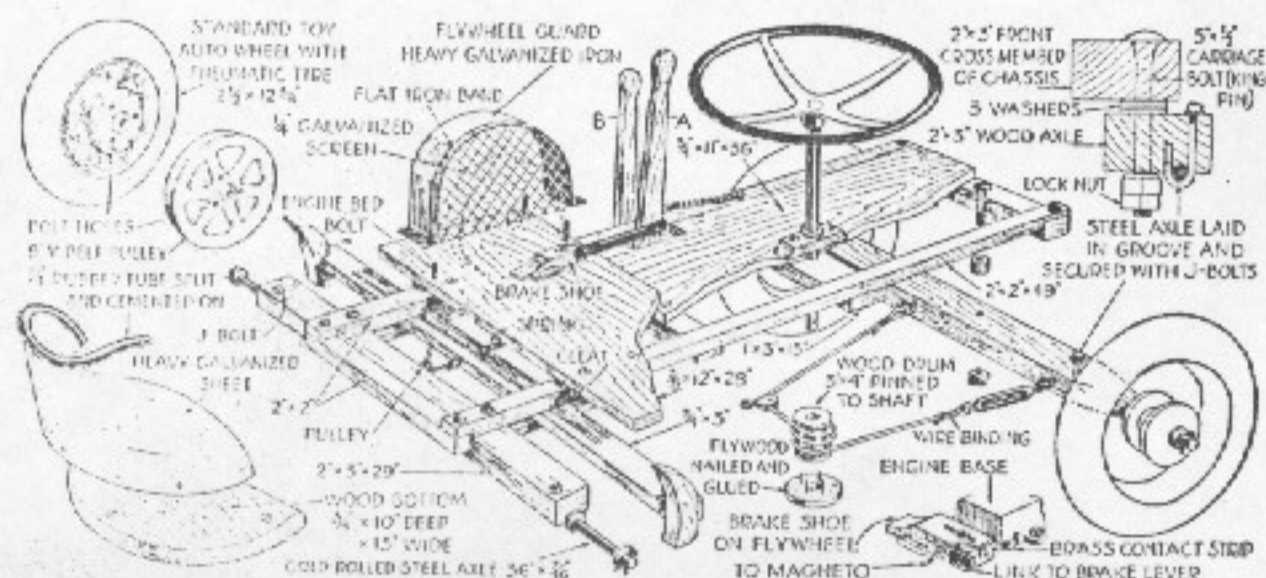
stretched to its limit, the screws are removed and the board set forward and screwed to a new position to keep the belt tight. With a first-class V-belt only one such adjustment will be required.

The steel axles are laid in grooves made in the wood axles and secured with J-bolts made by cutting off the heads of 1/4-in. carriage bolts and bending a hook in the end. The grooves in both the wood axles should be off center—in the front to allow for the kingpin and in the rear for the anchor bolts.

A sectional view of the front axle assembly is illustrated. In this connection bear in mind that while two-by-two's and two-by-three's are specified, the actual sizes of this material is considerably less when surfaced, but will be amply strong for the purpose.

The steering gear assembly is shown in the large perspective drawing. One point is important: have the cables approach the steering axle at equal angles, because the steering drum is off the center line and it is necessary to run the left cable through a pulley to overcome this and prevent slack. Use a good grade of sash cord and insert a turnbuckle to keep the cable taut at all times.

A 9-in. drive pulley is bolted to the hub

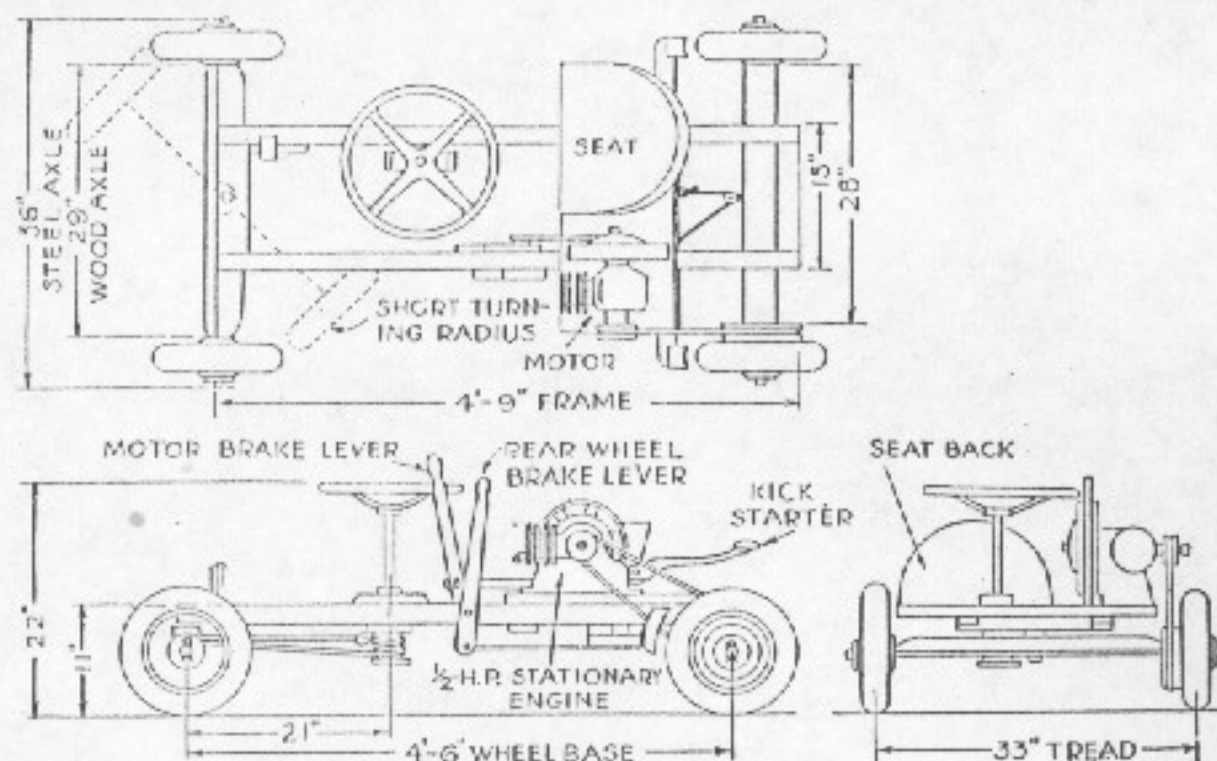


A partly broken away perspective drawing to make clear the chassis construction; details of drive wheel and pulley, bucket seat, flywheel brake and ignition cut-out, and kingpin assembly

of the left rear wheel, as shown. If there are grades to climb in your locality, use a 10- or even an 11-in. pulley. Note that the axle is stationary, and pulley and wheel turn freely on it.

While most small utility motors are provided with an ignition cut-out, the writer has constructed one in combination with a simple flywheel brake for greater convenience. This is illustrated in one of the small drawings and consists of a wooden brake shoe designed to be pushed against the flywheel by means of the hand lever marked *A* in the large drawing. The shoe slides along a wooden guide and is also slotted for a guide screw. A brass contact strip is wired to the magneto, and when the brake lever is pulled back, the brass touches the engine base and cuts out ignition. This type of brake and cut-out can easily be adapted to any design of motor.

The rear wheel brake is also highly efficient and easily constructed. It consists of wood shoes carried on a brake beam supported under the chassis and operated by a hand lever *B* through a sash-cord cable. A coil spring holds the beam forward when



General assembly drawings of the boy's auto with over-all dimensions. These views show the extreme simplicity of the chassis construction, the wide tread, and the low center of gravity.

Boy Mechanic, 1913

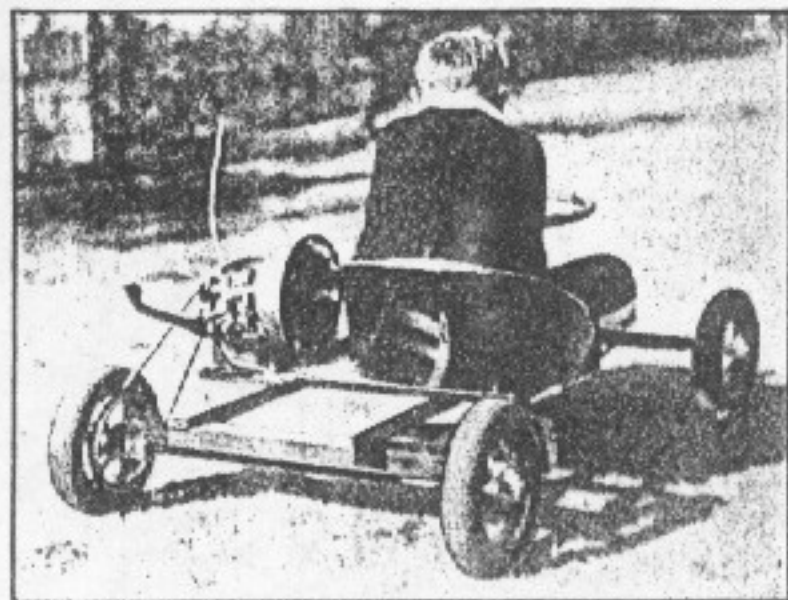
To Photograph a Man in a Bottle

Neither a huge bottle nor a dwarfed man is necessary for this process, as it is merely a trick of photography, and a very amusing trick, at that.

First, photograph the person to be inclosed in the bottle against a dark plain background and mark the exact position on the ground glass. Let the exposure be just long enough to show the figure distinctly. Then place an empty bottle against a dark background and focus so as to have the outlines of the bottle inclose those of the man. Let this exposure be about twice the length of the first, and the desired result is obtained.

A Musical Windmill

Make two wheels out of tin. They may be of any size, but wheel A must be larger than wheel B. On wheel A fasten two pieces of wood, C, to cross in the center, and place a bell on the four ends, as shown. The smaller wheel, B, must be separated from the other with a round piece of wood or an old spool. Tie four buttons with split rings to the smaller wheel, B. The blades on the wheels should be bent opposite on one wheel from the others so as to make the wheels turn in different directions. When turning, the buttons will strike the bells and make them ring constantly.

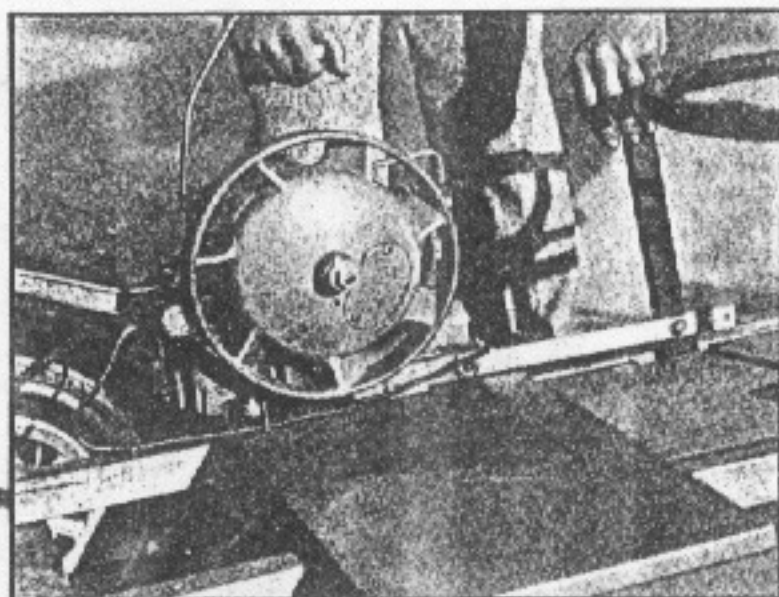


not in use. Note the shape of the shoes. Being above center, they are set at an angle.

The tendency of most midget car builders is to make them too large, heavy, and complicated. This one is simple and not much larger than a sled. In fact, the sensation of riding swiftly, smoothly, and so close to the ground is like tobogganing.

Transportation is the main aim, so no attempt is made to copy any features of big automobiles. Incidentally, this wagon is so small that it can be shoved under the porch or into a spare corner of the garage. And being so small and hung so low, its maximum speed of 17 M.P.H. (the motor has a governor) seems much faster.

The V-belt pulley is fastened to the wheel with three bolts. Both turn freely on the axle.



When the flywheel is applied, it cuts out the ignition.

Seven Ways to Build Comfortable DOG HOUSES

Popular Science Monthly

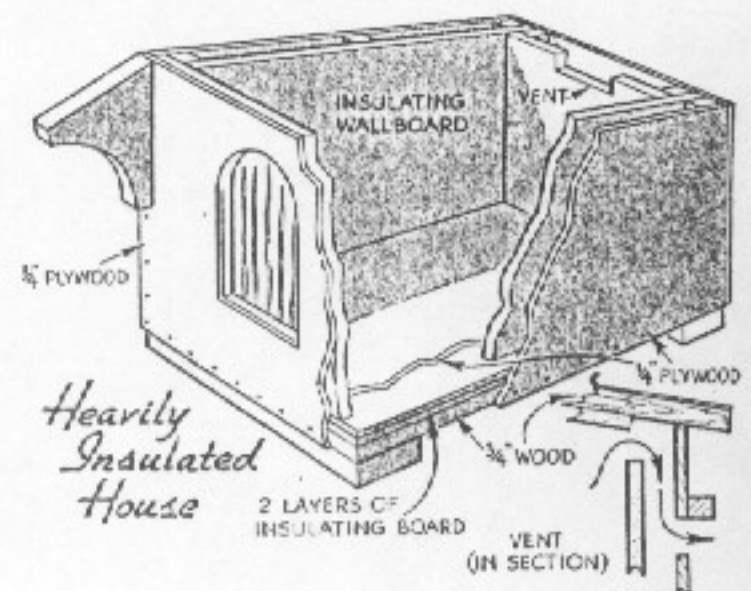
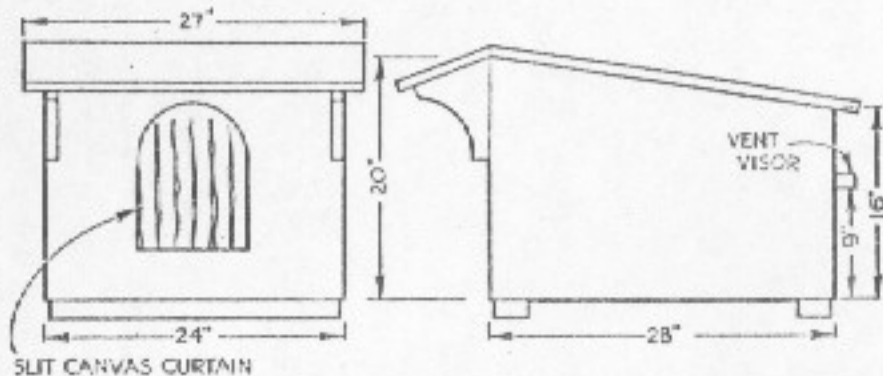
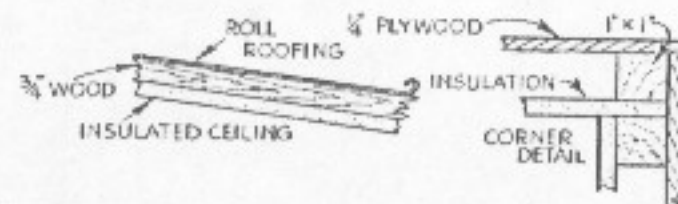
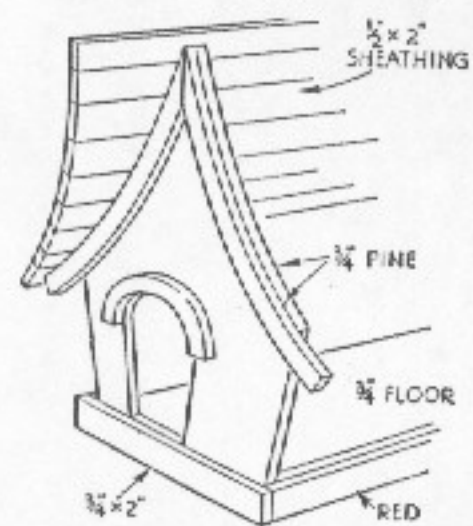
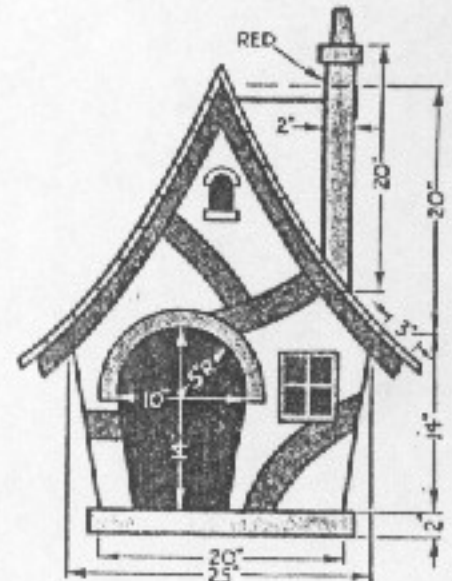
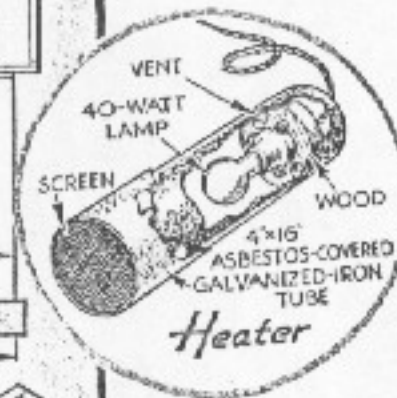
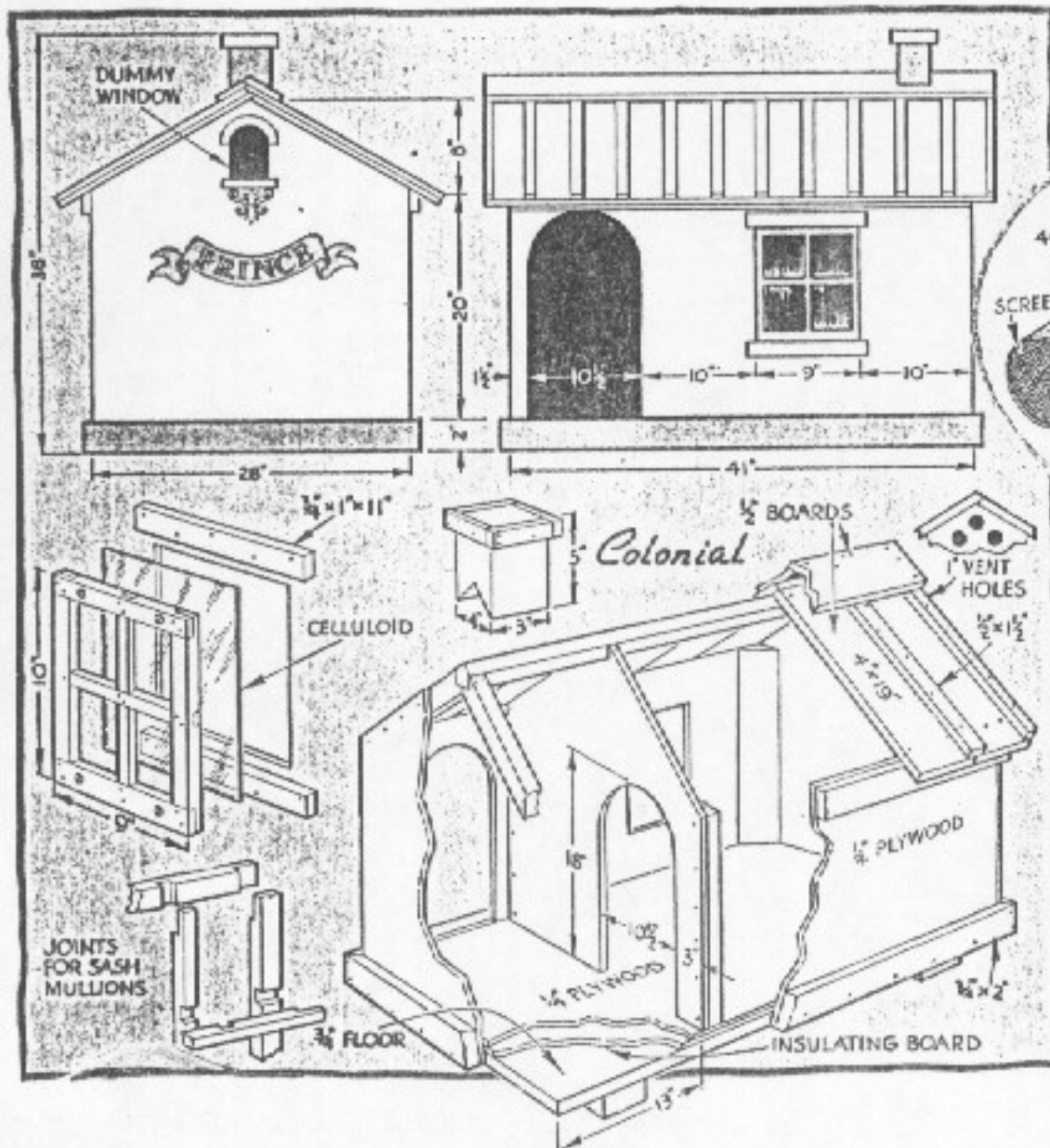
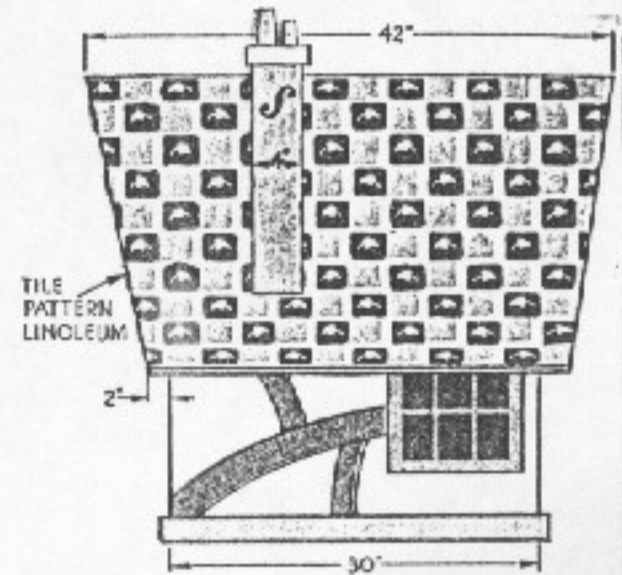
SEPTEMBER, 1936

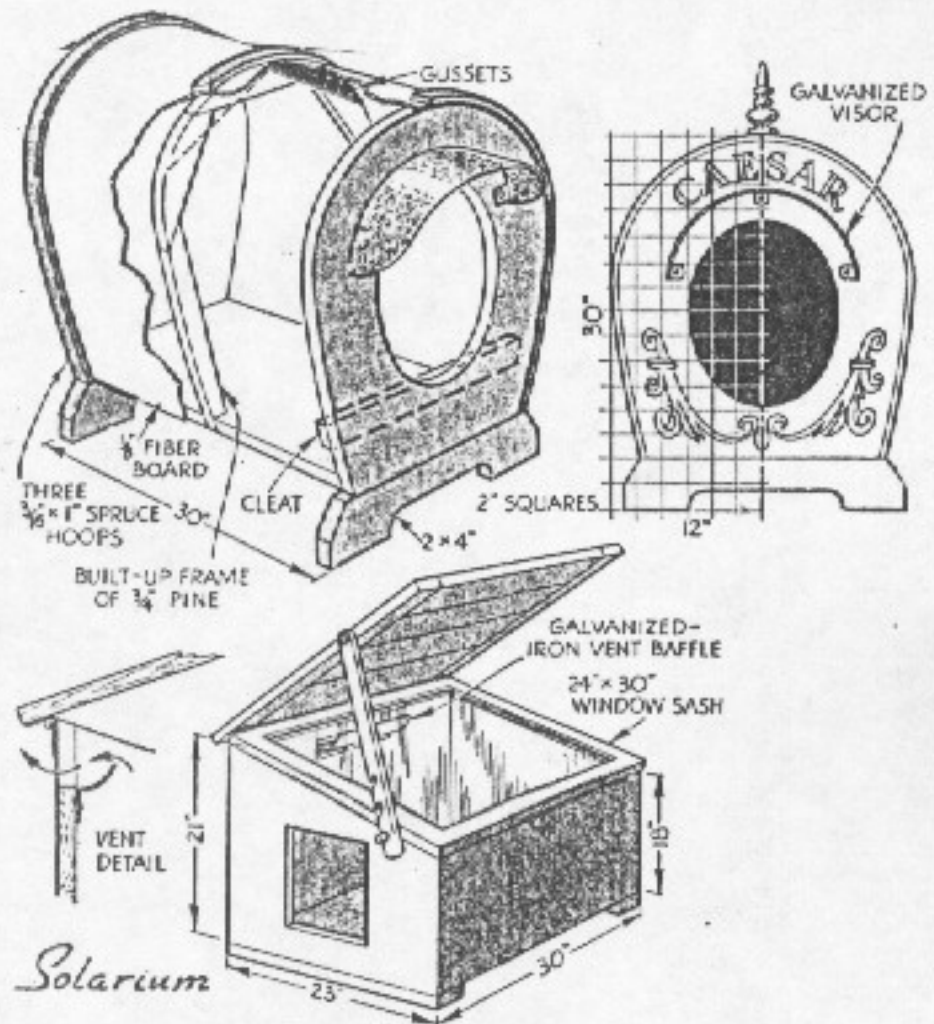
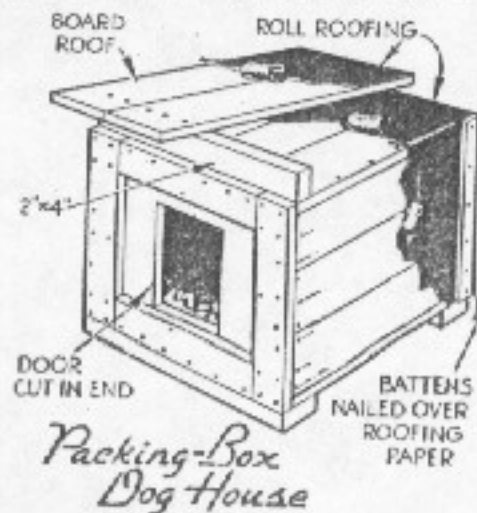
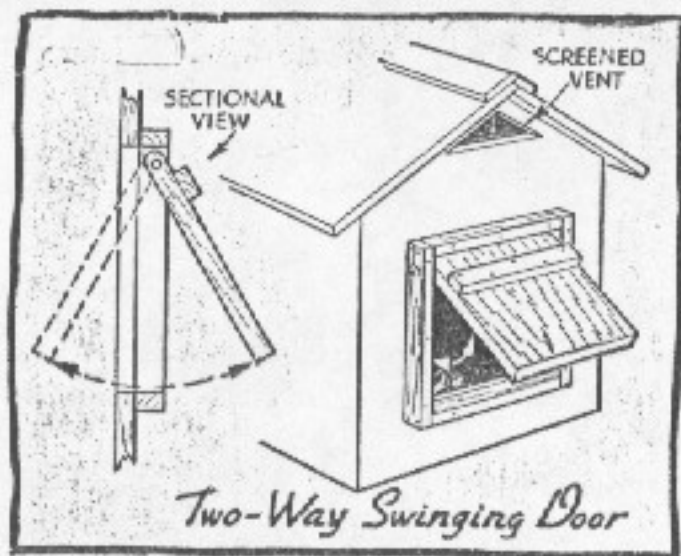
By HI SIBLEY

DOGS appreciate comfort so much that it gives genuine satisfaction to build good houses for them. The designs illustrated are suitable for a wide variety of conditions, and the dimensions can be adapted to the individual pet. Warmth, freedom from drafts, and cleanliness are important. For the house located out of doors, excelsior makes an excellent bed because it can be removed periodically and burned.

Fairy-Tale Cottage

BLACK DUMMY WINDOWS WITH GREEN FRAMES
BROWN TIMBERWORK
CREAM WALLS



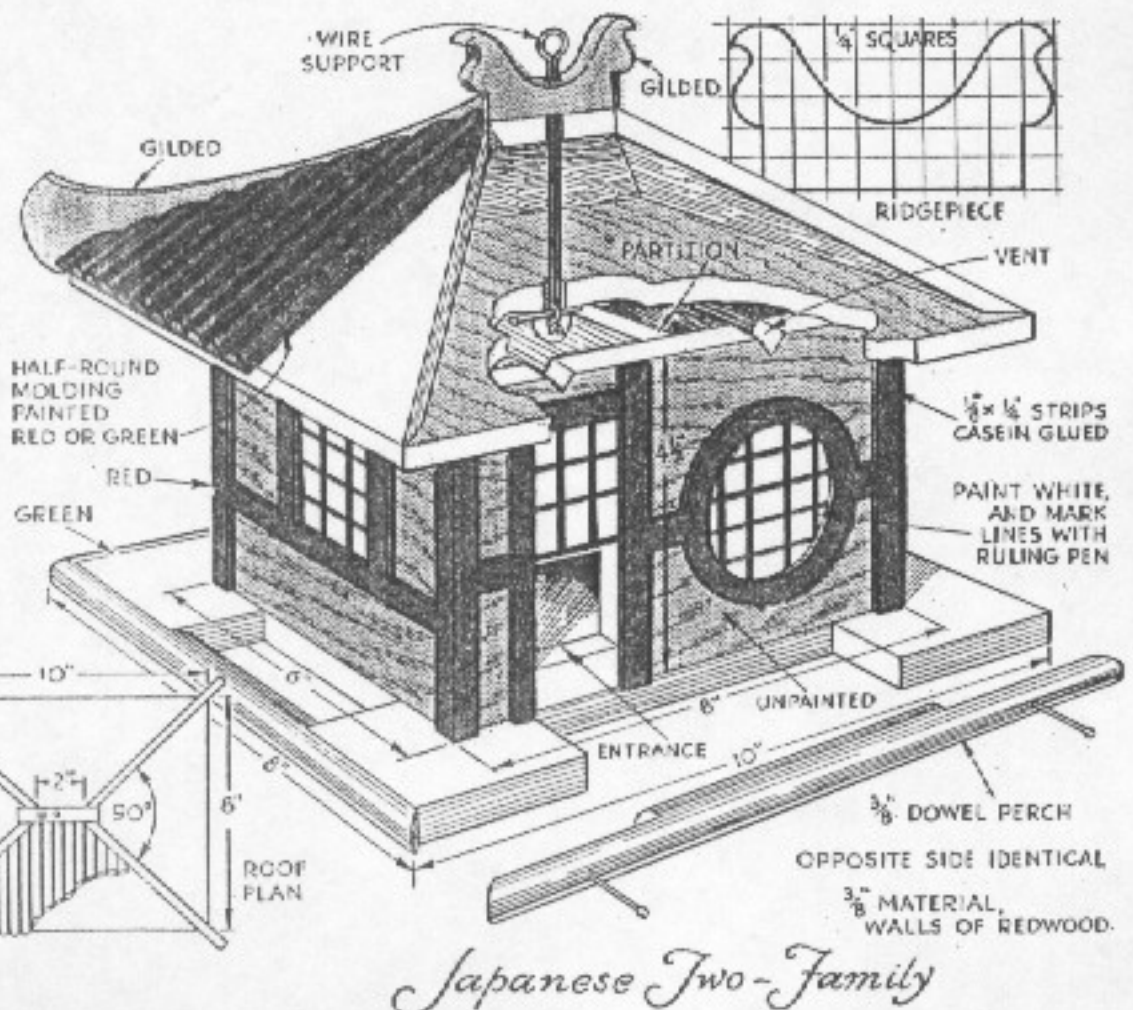
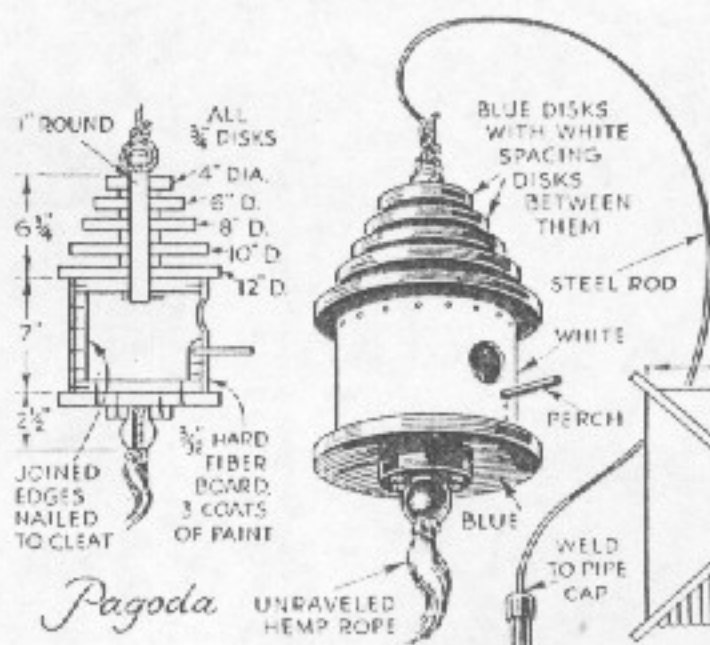


BIRD-HOUSE Building

By Hi Sibley

POPULAR SCIENCE MONTHLY

MARCH, 1936

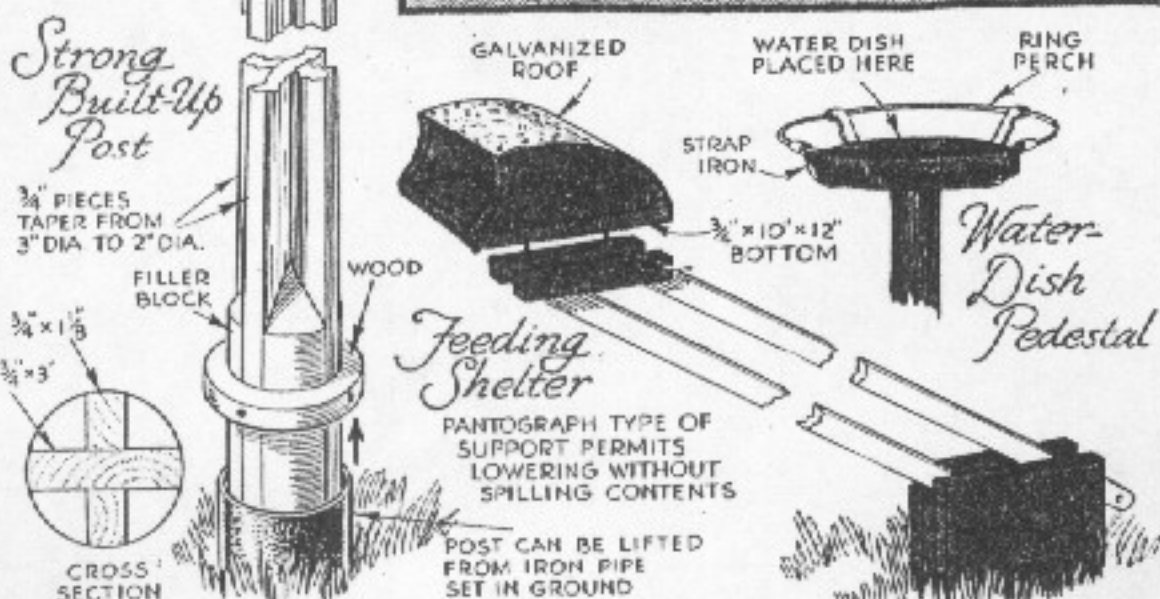
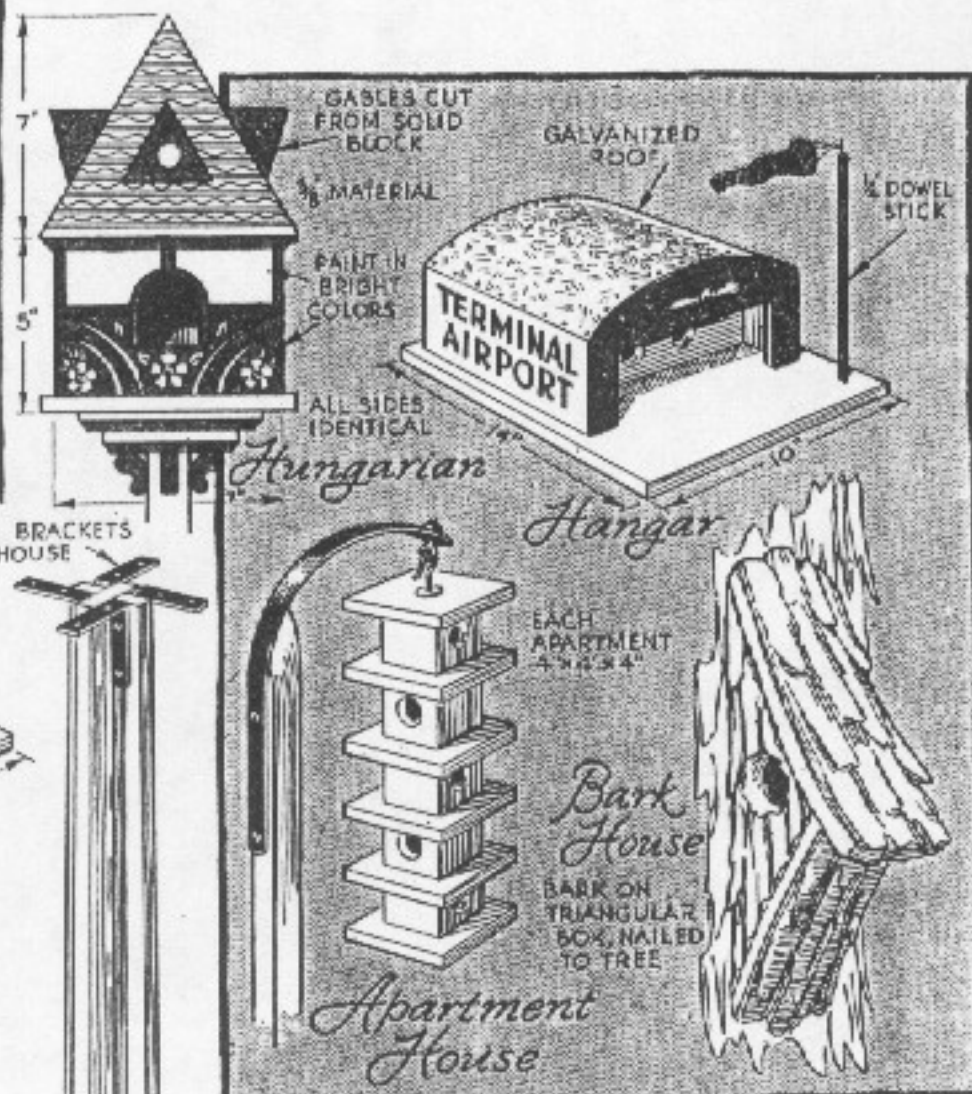
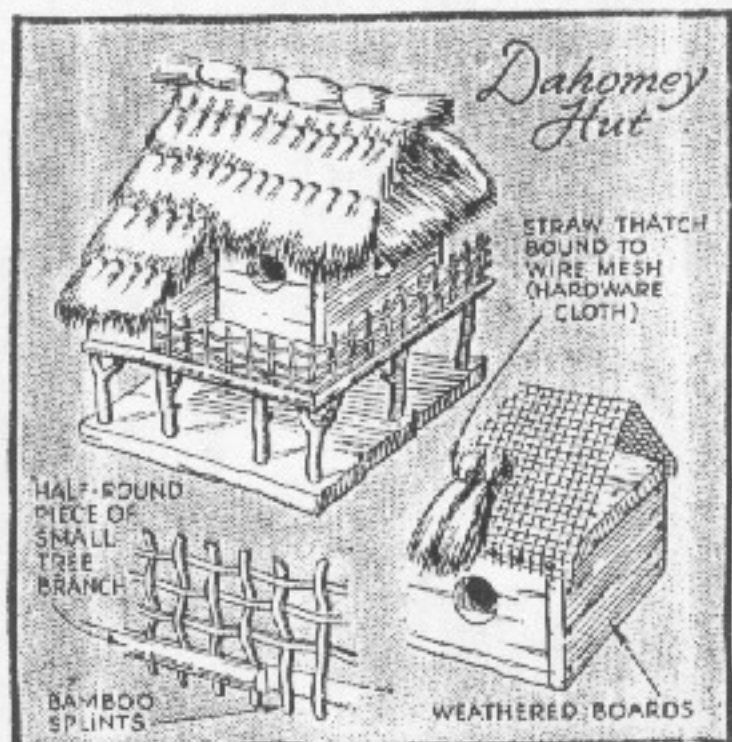
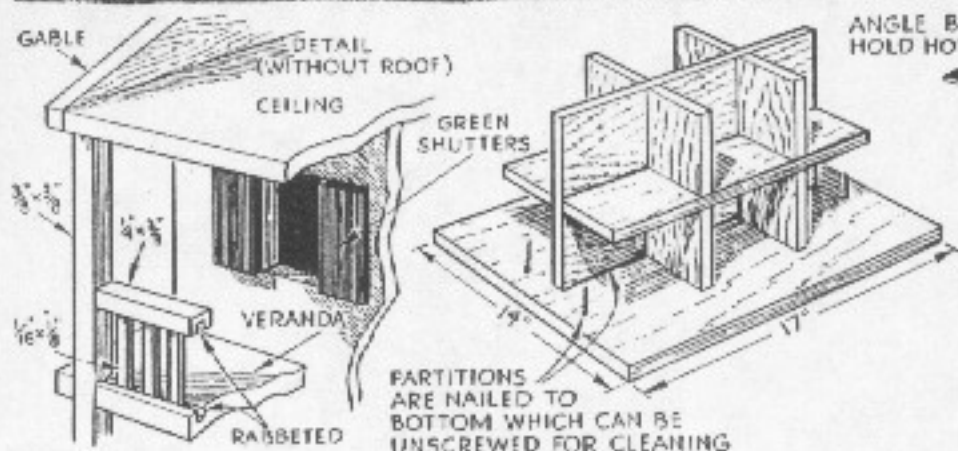
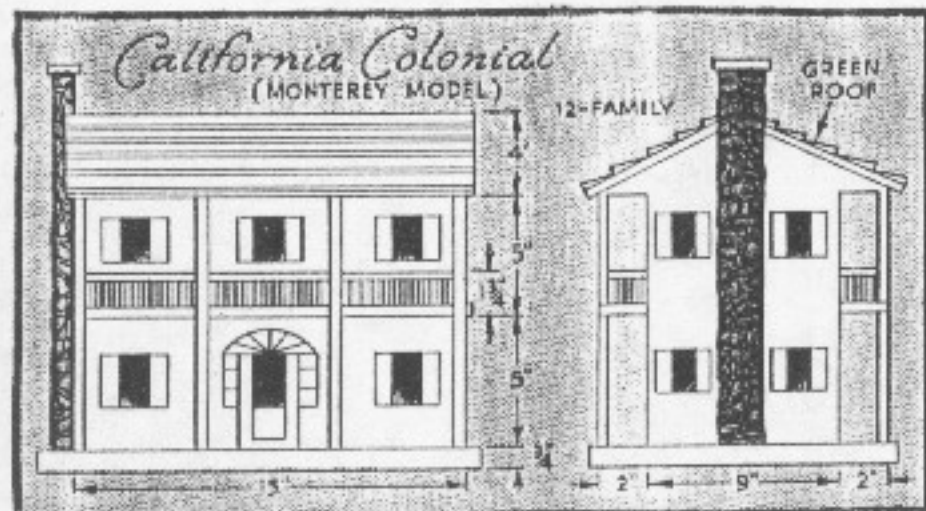


Decorative bird houses add to the attractiveness of any garden. Here are many novel suggestions.

THE BEST SIZES TO MAKE BIRD-NESTING BOXES

Species	Floor of cavity	Depth of cavity	Entrance above floor	Dia. of entrance	Height above ground
Bluebird	5 x 5 in.	8 in.	6 in.	1 1/2 in.	5-10 ft.
Robin	6 x 8 in.	8 in.	one side open	one side open	6-15 ft.
Chicadee	4 x 4 in.	8-10 in.	6-8 in.	1 3/8 in.	6-15 ft.
House wren	4 x 4 in.	6-8 in.	1-6 in.	1 in.	6-10 ft.
Barn swallow	6 x 6 in.	6 in.	one side open	one side open	8-12 ft.
Flicker	7 x 7 in.	16-18 in.	14-16 in.	2 1/2 in.	6-20 ft.
Red-headed woodpecker	6 x 6 in.	12-15 in.	9-12 in.	2 in.	12-20 ft.

NOTE: See page 70 for designs. Houses on poles are preferred to those in trees (unless suspended) because they are safer from natural enemies. The above dimensions are recommended in *Homes for Birds*, published by the U. S. Department of Agriculture.



Alligator Toy Has Flexible Spine

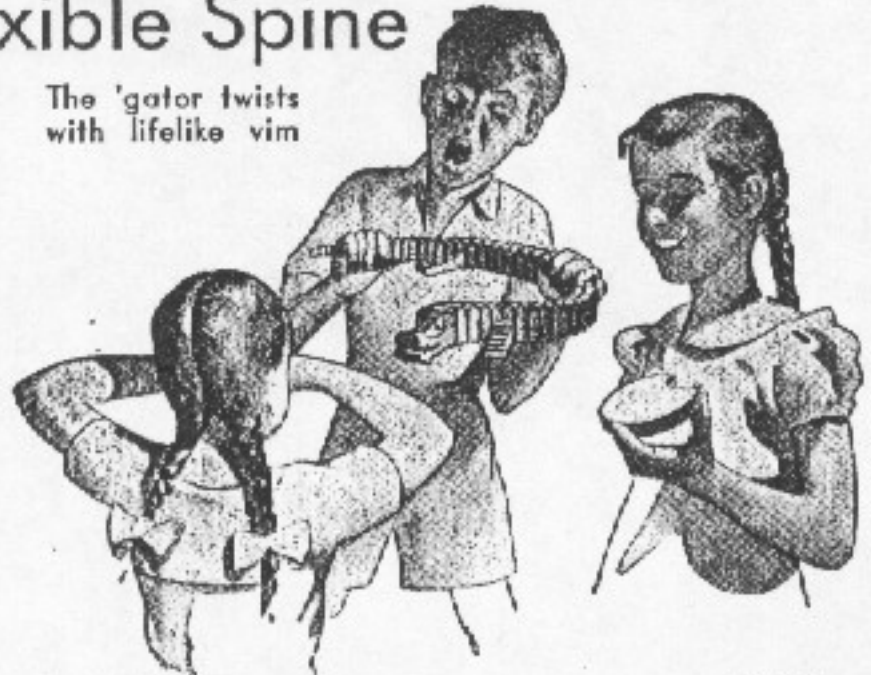
THIS amusing toy, the "twistum 'gator," is made of wood segments glued to a heavy canvas core or spine about 2' 6" long.

After cutting the canvas, make two identical pieces for the head with coping saw or scroll saw and glue these opposite each other on the canvas. Then saw, or have sawed, a strip $\frac{3}{4}$ " by $\frac{3}{4}$ " by 5' or 6' with the saw table top tipped to an angle of about 15 deg., so that the two opposite edges of the strip are on an angle as shown. Cut another strip or two $\frac{5}{8}$ " by $\frac{3}{4}$ " by 6', also beveled on two opposite sides to a 15-deg. angle.

With knife or saw, cut the end of one of the $\frac{3}{4}$ " strips to a sharp edge, like the roof of a gabled house. Cut this end off 3" long, point the stick again, and repeat. Glue these pieces opposite each other close against the head with the $\frac{3}{4}$ " face fastened to the spine.

The remaining body

The 'gator twists with lifelike vim



GIANT HOME WORKSHOP MANUAL 1941



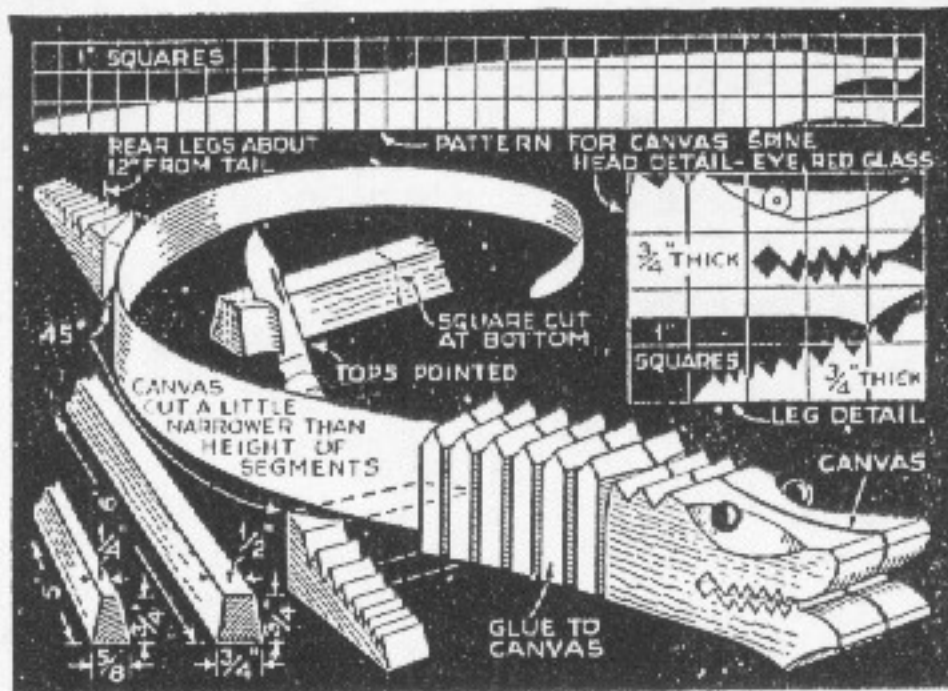
Wooden segments are glued to the sides of a spine of canvas

work is a repetition of the process. The first six pairs are about 3" long, then taper off slowly and gradually a little more than $\frac{1}{16}$ " at a time until at the end of the tail they are only about $\frac{1}{2}$ " tall. For the first dozen segments use

the $\frac{3}{4}$ " strip; for the remainder, use the $\frac{5}{8}$ " pieces. Near the tail, trim off the outside faces so as to get a gradual taper to the tail. The segments for the last inch or so may be carved in a single piece.

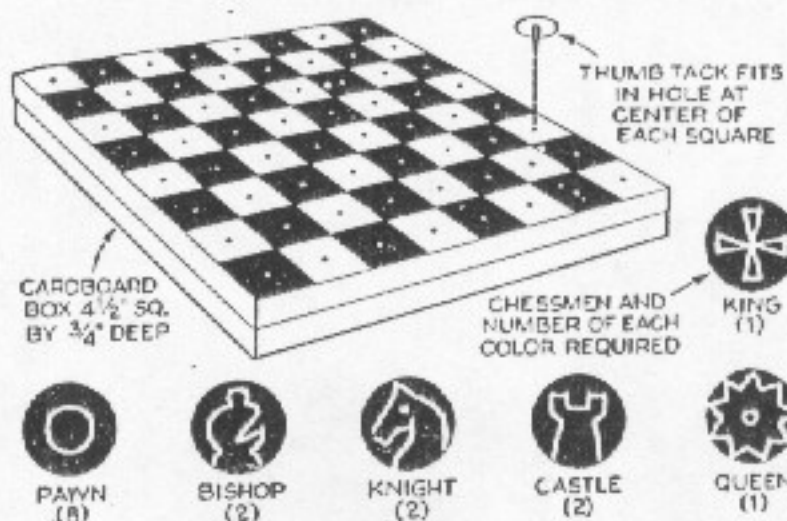
The legs are solid saw-toothed strips cut at an angle of 45 deg., and each is glued and nailed to two segments of the body. The body is painted green with red on the teeth, and the eyes are red beads.

Any kind of wood will do for the 'gator although soft wood is easier to whittle.



Layout for the spine and how the wooden parts are added

Thumb Tacks Converted into Pocket Chess Set



A POCKET chess set can be made for a few cents from sixteen thumb tacks with cream-colored metal heads, sixteen thumb tacks with maroon-colored heads, and a cardboard box about $4\frac{1}{2}$ " square and $\frac{3}{4}$ " deep. The tacks are made into chessmen by scraping lines through the enamel on the heads to form the patterns. This can be done with an awl or large needle. The top of the box is marked with ink to represent a chessboard, and a hole is punctured in the center of each square so a thumb tack can be dropped in.

SLICE OF NINETEENTH CENTURY LIFE



RUNNING WITH FORTY.

Harper's Monthly Magazine

OUR CHARLEY.

September 1858

I **TOUGHT** to be a happy woman.

We live in a neat house, in a pleasant neighborhood. By *we* I mean my husband and myself; Charley, his father's namesake, our son and heir, aged seven years; the baby, two years old, whose name stands in our Family Bible as Mary, which becomes Minnie when spoken; and Ellen O'Brien, cook and maid of all work.

My husband is in a very comfortable business, large enough to supply our moderate wants, and leave something over, even in these hard times; yet not so large as to compel him to make a slave of himself to manage it. He goes to his work at nine o'clock; this gives him time to read the paper, chat with me, play with the children, and breakfast leisurely. He comes home at five; so that he can rest, dress, dine at six, and be ready for any arrangement that we may have made for the evening. These, I take it, are just the right hours for a husband. He is not at home enough to be in the way, and is absent just long enough to be glad to see me when he returns.

Our Ellen is a jewel. She can broil a steak, make capital coffee, and even boil a potato. With a little assistance from me she gets up my husband's linen in a way that satisfies his critical taste; and never grumbles at taking care of baby or looking after Master Charley. She never flirts in the area with the butcher or milkman, or dawdles at the Dutch Grocery on the corner. She is proof against the blandishments of itinerant peddlers and book agents. The smoothest-tongued of all the tribe never yet succeeded in inducing her to leave him alone in the hall while she went to call the "Lady of the House." She has cousins in plenty—as what genuine Milesian girl has not?—but they only visit her at reasonable hours, and never undertake surreptitious forays upon

the tea-caddy or sugar-basin. If she makes tea for them, she does it openly and above-board, as though she had a perfect right to do so—as indeed she has—for "servants" are human beings, and have a just claim to the gratification of kindly feelings. Foremost among her cousins is Patrick Brady, a strapping, fresh-looking bricklayer, with a nice little account in the Savings' Bank, and a lot in Brooklyn, upon which, they say, he is building a house. He makes his appearance in our kitchen two evenings in the week. There is no concealment or subterfuge when I happen to "drop down," as I make it a point to do. Mr. Brady wishes me good-evening with the air of a man satisfied with himself and his position—which is perfectly right, for when the Brooklyn house is completed, our Ellen is to be installed in it as Mrs. Brady, and I know that I shall always be kindly welcomed there. Twenty years hence, if all goes well, I dare say Mr. Brady will be a richer man than my husband.

Baby is never sick, and rarely cries. My husband never comes home tired out and cross; or hints that my milliner's bills are ruining him; or grumbles out a curse at the mention of Stewart or Brodie.

With such a husband, baby, and "help," I ought to be, as I began by saying, a happy woman. So I should be were it not for Charley.

How that seven-years-old urchin manages to get into so many scrapes, perpetrate such an infinite deal of mischief, and pick up such a variety of queer acquaintances, passes my comprehension. I can not keep him in-doors all day, yet I never let him go out for a run in the Parade Ground without feeling sure that he will come back escorted by a troop of ragged, dirty followers, and minus some article of dress which he has given or swapped away. He has a natural affinity for shipwrecked sailors, old-clothes' men, and dog-sellers. If he could lead about an organ-grinder's monkey he would be perfectly happy. He is ready to strike up a friend-

ship with any urchin who has an unwashed face, crownless hat, and ragged nether garments.

Looking from the window not a week ago, I saw him with his father's new hat and best coat in his hand, in deep consultation with a Dutch peddler. The faithful Ellen rushed out in time to prevent the consummation of the bargain. Upon descending to the street I found that he had traded off a vinegar-cruet, two silver-forks, his cap, and one of baby's frocks, for two razors, a bunch of cinnamon cigars, six sticks of candy, a piece of colored soap, and a dozen steel pens. The Dutchman could not speak a word of English, but was negotiating by signs for the purchase of my husband's coat and hat. He had offered a jack-knife, plaster casts of Little Samuel, General Jackson, and the Babes in the Wood, three packages of lozenges, a paper of pins, two dozen pearl buttons, and a wooden shaving-dish. Charley was standing out stoutly for a Jew's-harp, a crying baby, and a bottle of Cologne, in addition, when the opportune arrival of Ellen put a stop to the business.

The very next day Master Charley came rushing to me.

"Mamma," he asked, "mayn't I run with Forty?"

I consented, though I had not the remotest idea what running with Forty meant.

"That's gallows!" shouted Master Charley. "Look out for the bull-gine when the bell rings! Nix cum raus! Jim-along-Josey!"

He was away before I could recover myself from my astonishment. Where can the child have picked up such phrases?

Half an hour later, hearing a great noise before the door, I looked out. There was our Charley at the head of a squad of a dozen ragged urchins. They had rigged an old candle-box upon wheels, with something that looked like the breaks of a fire-engine on the top. Charley, his long curls flying in the wind, was making a most unearthly tooting upon a tin horn. Pasteboard badges stuck in their caps bore the number 40. I now began to understand what "running with Forty" meant.

Having dutifully honored their captain's family by a salute, the juvenile firemen dashed around the corner before I could summon Master Charley.



AIN'T HE A BEAUTY?

In an hour my hopeful son made his appearance, but sadly changed. His long curls had been clipped off close to his head, giving him a most hang-dog, villainous aspect.

"Charley," said I, "what have you been about?"

"Been havin' my hair cut, regular fightin' fashion. Just like Jake's."

"Like Jake's! Who is Jake?"

"Oh, he's a real nice little boy. His ma sells candy and cigars. She gave me two sticks of candy and a cigar for my handkerchief; and Jake gave me such a pretty dog for my cap, my new knife, and six cents. He's such a pretty dog, and his name's Growler. I'll go and fetch him."

Charley bolted from the room, and soon returned lugging in a half-starved, mangy mongrel, almost as big as himself.

"Ain't he a beauty, mamma? Jake says he can kill rats and worry cats beautiful. Mayn't he sleep in my bed? He barks so gallows."

"Growler, true to his name, set up a terrific howl, and snapped viciously at his new master. Charley dropped the brute, who darted under the sofa, and lay there, obstinately refusing to be coaxed out, and snarled and showed a formidable set of teeth when any one approached him. Charley began to cry. His new acquisition had suddenly lost all its charms.

"Lemme call Jake. He'll catch him!" he whimpered; and rushing out, he soon returned with his nice friend, whose original style of coiffure had so captivated him.

After a vigorous hunt around the room, in the course of which Growler contrived to demolish sundry articles of crockery and commit sad havoc among the books and papers, Jake managed to secure the cur.

"There, Jake, you may have him. I guess I don't want him," sobbed Charley.

"Gimme a shill'n for ketchin' on him," whined Jake.

The shilling was produced, and Master Jake departed with his prize, to the great relief of Charley.

What shall I do with the boy?



GROWLER

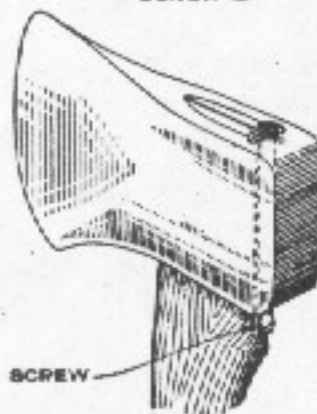
GIMME A SHILL'N.



CHARLEY'S SPECULATION.

Holding Ax Heads in Place Popular Mechanics, 1925

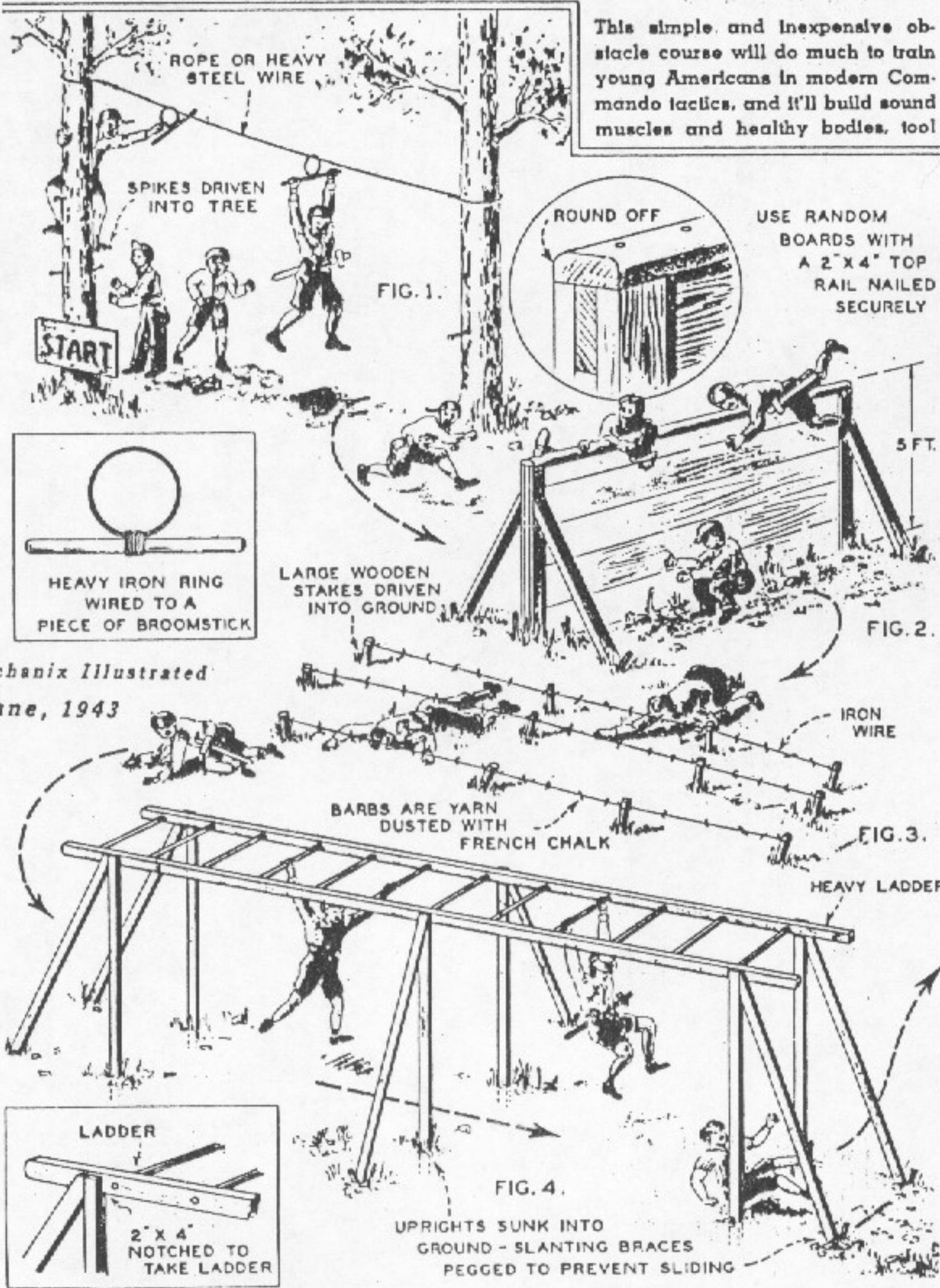
It is not always possible to tell when an ax head is fastened securely enough to prevent the possibility of accident,



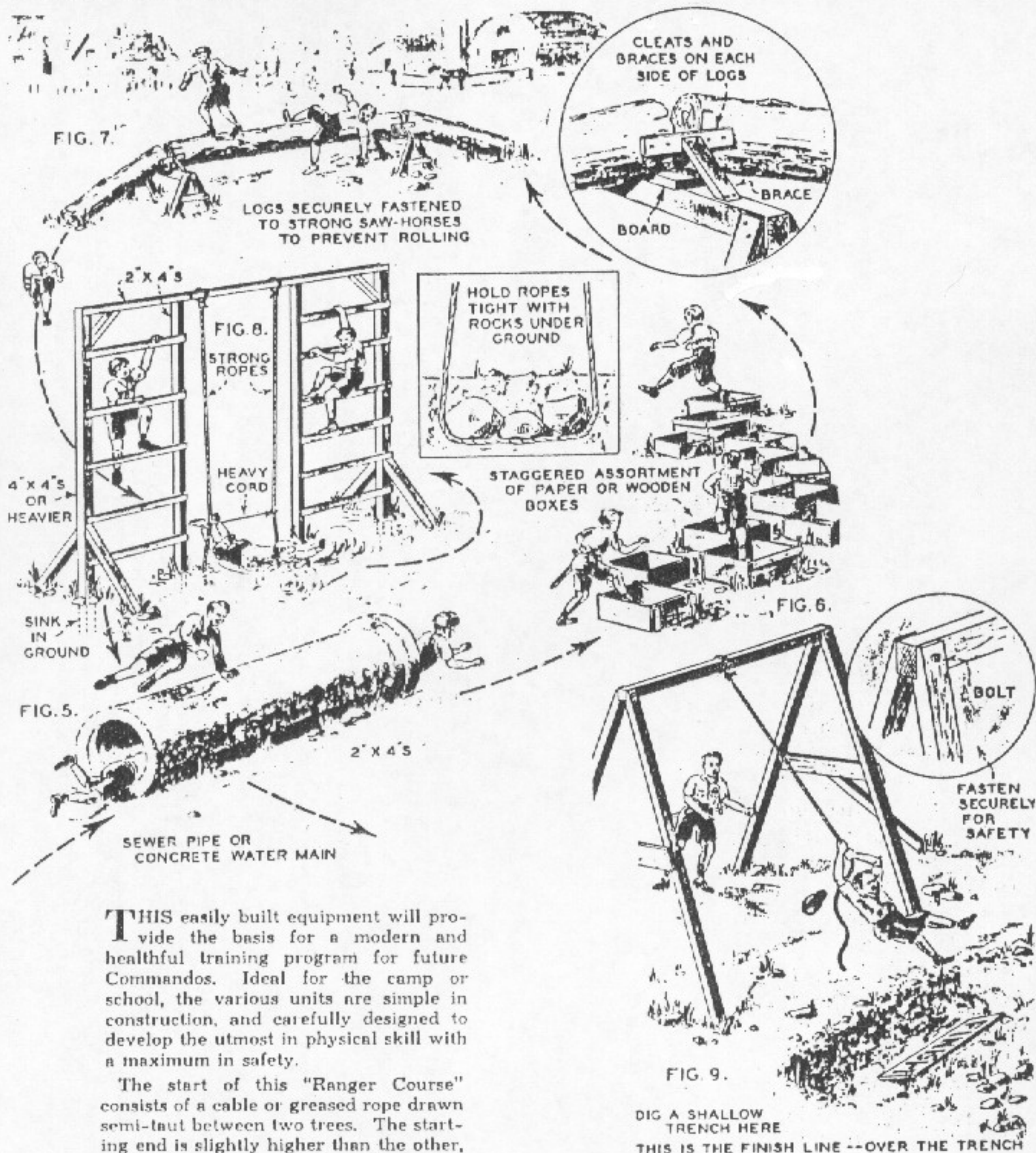
especially when using a heavy ax in winter; but by using the simple method shown in the drawing, the ax may be made permanently safe. A pin is made of $\frac{1}{16}$ -in. sheet iron to the pattern shown, and after the head has been wedged in place, the pin is driven in until the shoulder bears against the head. A screw

is then driven into the handle through the hole in the pin; this will keep the head from flying off, even if the wedges loosen and drop out.

BACKYARD RANGER COURSE



Mechanix Illustrated
June, 1943



THIS easily built equipment will provide the basis for a modern and healthful training program for future Commandos. Ideal for the camp or school, the various units are simple in construction, and carefully designed to develop the utmost in physical skill with a maximum in safety.

The start of this "Ranger Course" consists of a cable or greased rope drawn semi-taut between two trees. The starting end is slightly higher than the other, so that the trainees will be able to slide along it. The spikes up the sides of the trees or posts should be driven either on the sides of the trees or on the back, away from the cable. This keeps them out of the way of the participants, and eliminates all chance of catching clothes on spike heads.

Do not incline this cable steeply, lest the

sliding speed be too high for safety.

From the cable obstacle, the junior trainees head for the 5-ft. plank fence. Note that the top of this fence is carefully rounded to prevent possible scratches to the hands of the participants. Since the entire Ranger Course should be made a competitive game

on a time basis, it must be remembered that enthusiasm will take the participants along it at considerable speed, and so all precautions are taken in building it, in order to prevent mishaps.

When the plank fence (Fig. 2) has been scaled, the youngsters must traverse the "barbed wire." This is not really barbed, but merely straight galvanized wire or even cord, with small bits of yarn tied to it at intervals. The yarn is dusted with French chalk or other powder of similar nature, so that the participants will know, when the course is completed, if they have come in contact with the "barbs." This obstacle is illustrated at Fig. 3.

The next step in the course is the ladder bridge, which must be traversed as illustrated (Fig. 4). The ladder is supported above the ground by a number of uprights, as shown. The height of the ladder should be gauged in construction of the unit, so that the youngster's feet will be only a short distance above the ground. It is important that the feet clear the ground completely, but that no appreciable drop be necessary in the event of failure of the participant to successfully negotiate the "hazard."

Fig. 5, the next step along the way, is simply

a large concrete pipe. The youthful trainees must crawl through this in order to reach the series of boxes shown in Fig. 6.

The boxes (Fig. 6) are designed to develop co-ordination of the leg muscles to the nth degree. These boxes are built up of wood, and should be rounded on the top to keep the less sure-footed of the contestants from skinning their shins.

The log bridge shown in Fig. 7, is the next stage in the course. Its purpose is that of improving the contestant's sense of balance, and to permit him to exercise it fully.

Next come the

ladders (Fig. 8). The participants climb up one side, down the other—first on one ladder, then on the other. After the ladder work, they must run around the obstacle and slide under the rope square in the center (at the bottom).

A path from this point leads to the final stage of the training game, the rope swing. The contestant must swing clear over the soft earth hollow while holding to the rope with his hands. The first one to accomplish all these training feats is the winner. (See Fig. 9.)

You shape, bake, paint baker's clay

SUNSET

DECEMBER 1968

Baker's clay, an inedible dough, is a material used in the very old art of ornamental baking. Painted with water colors and sprayed with clear plastic or lacquer, it makes Christmas ornaments that have great charm.

To make the clay, combine 4 cups of unsifted flour, 1 cup of salt, and 1½ cups of water in a bowl. Mix well to form a stiff dough (add more water if necessary), then remove to a board and knead for about 5 minutes.

Use a rolling pin to roll the dough out to ¼-inch thickness (don't make the ornaments too thin), then cut the shapes with a knife or cookie cutter. Lift each one to a cookie sheet and decorate with little balls or ropes of dough or use any handy kitchen tool to create textures—for example, dough pushed through a garlic press for hair or evergreen branches. Finally, make a hole with a pencil point at the top of the ornament for a hanger.

Bake the ornaments in a preheated 350° oven for about 1 hour or until hard—use a tester to be sure they are done—then remove from the oven and transfer to a rack to cool. To finish, paint the orna-

ments with water colors or poster paint, then give them a coat of clear varnish, lacquer, or plastic. This will prevent their getting soft and spoiling. *NOTE: Don't try to double the dough recipe, and use it up within about 4 hours.*

DARROW M. WATT



Cut shape from dough, decorate, bake

Acid and Alkali.—Put a lump of chalk into a glass of vinegar, and the effect will be a hissing, between the acid and the chalk, which will continue for a long time, denoting the action of acid and alkali when in contact.

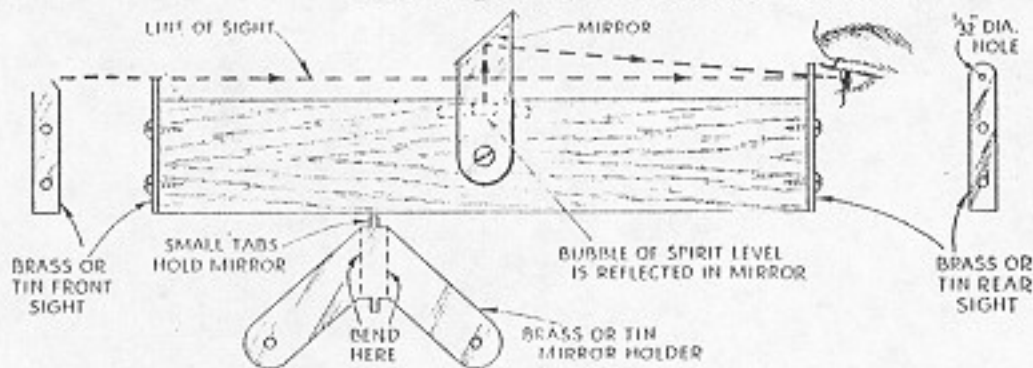
Artificial Lightning.—Provide a tin tube that is larger at one end than it is at the other, and in which there are several holes. Fill this tube with powdered resin, and when it is shaken over the flame of a torch, the reflection will produce the exact appearance of lightning.

Camphor Tree.—Dissolve camphor in warm spirits of wine until the spirits will dissolve no more; pour some of the solution into a cold glass, and the camphor will instantly crystallize in beautiful tree-like forms.

To Tell the Distance of Thunder.—Allow a little more than five seconds for a mile in reckoning how many seconds elapse between when you see the lightning and hear the thunder. If you have no timepiece, you can tell by the pulse-beats, giving five thousand feet to six beats.

Cologne and aftershave can be made by mixing 8 oz of rubbing alcohol or 100 proof grain alcohol with 1/2 teaspoon ginger, 1/2 teaspoon allspice and a dozen cloves. Pour into a jar with a screw-on-top, shake twice daily for about three weeks. Filter through a cloth and mix with some water.

Popular Science Monthly December, 1935



Simple Leveling Device

MOUNT a small mirror and two metal sights on an ordinary bubble level as shown in the photograph and sketch. In sighting, move the level until the bubble, seen in the mirror, is in the center of its "level" position. Then look past the end sight to determine the point where the horizontal line of sight strikes.



Dear Mr. Saxon,

Below is the list of herbal resources we discussed over the phone. The code beside them is as follows: S - seeds P - plants D - dried herbs M - medicinal (aromatherapy, homeopathic) H - herbal products (non-medicinal)

Great Lakes Herb Company, P.O. Box 6713 Minneapolis MN 55406 \$1.00 N, D
 Goodwin Creek Gardens P. O. Box 83-C Williams OR 97544 \$1.00 S, P
 Nichols Garden Nursery 1190 S. Pacific Albany OR 97321 free S, P
 Lilly of the Valley Herb Farm 3969 Fox Avenue Minerva OH 44657 \$1.00 S, P, D
 Well Sweep Herb Farm 317 Mt. Bethel Road Port Murray NJ 07865 \$2.00 D, P
 Renaissance Acres 4450 Valentine Road Whitmore Lake MI 48189 \$2.00 S, P, D
 Meadowsweet Herb Farm 7290 Mount Holly Road Shrewsbury VT 05738 \$1.00 S, D
 Country Mouse Herbal Nursery 11780 W. Hafeman Road Orfordville WI 53576 \$1.00 H, D
 Frontier Coop Herbs P. O. Box 299 Norway IA 52318 \$2.00 D, H
 Starwest Botanicals, Inc 11253 Trade Center Drive Rancho Cordova CA 95742 D, H
 Abundant Life Seed Foundation P. O. Box 722 Port Townsend WA 98368 \$2.00 S
 Haussman's Pharmacy 534-536 W. Girard Ave Philadelphia PA 19123 \$1.00 H, D
 Logee's Greenhouses 55 North Street Danielson CT 06329 \$3.00 S, P
 Herbal Endeavors Colleen Dodt 3618 S. Emmons Ave Rochester Hills MI 48063 N, H
 Flowery Branch P.O. Box 1330 Flowery Branch GA 30542 \$2.00 S
 Clement Herb Farm Rt 6 Box 390 Rogers AR 72756 .50 S, P
 Herb Gathering 5742 Kenwood Kansas City MO 64110 .50 S
 Sequoyah Gardens Rt 1 Box 80 Gore OK 74435 \$1.00 S, P, H
 McKeown's Herbs 6095 Harrison Rd Coloma MI 49038 free P, S, H, H
 Woodlanders 1128 Colleton Ave Aiken SC 29801 \$1.00 S, P

OTHER: Essentials 'n Such 3999 N. Chestnut Ave Ste 368 Fresno CA 93726
 Bottles, tins, sprayers, bags, oils lids, and other accessories.

Hope this is of help,

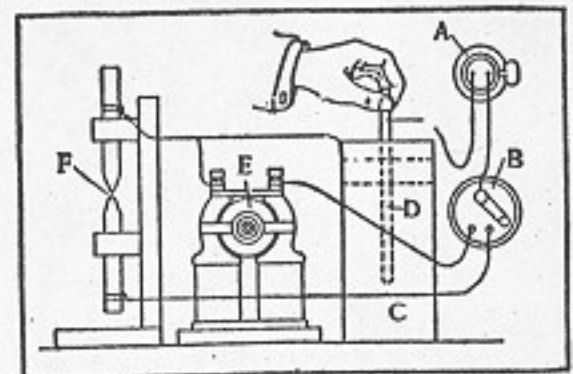
Sincerely,
Sena
The Herbal Spirit

Sena Brothers 1745 NW 12 Olathe City OK 73106

Boy Mechanic 1913

Easy Experiments with Electric-Light Circuit

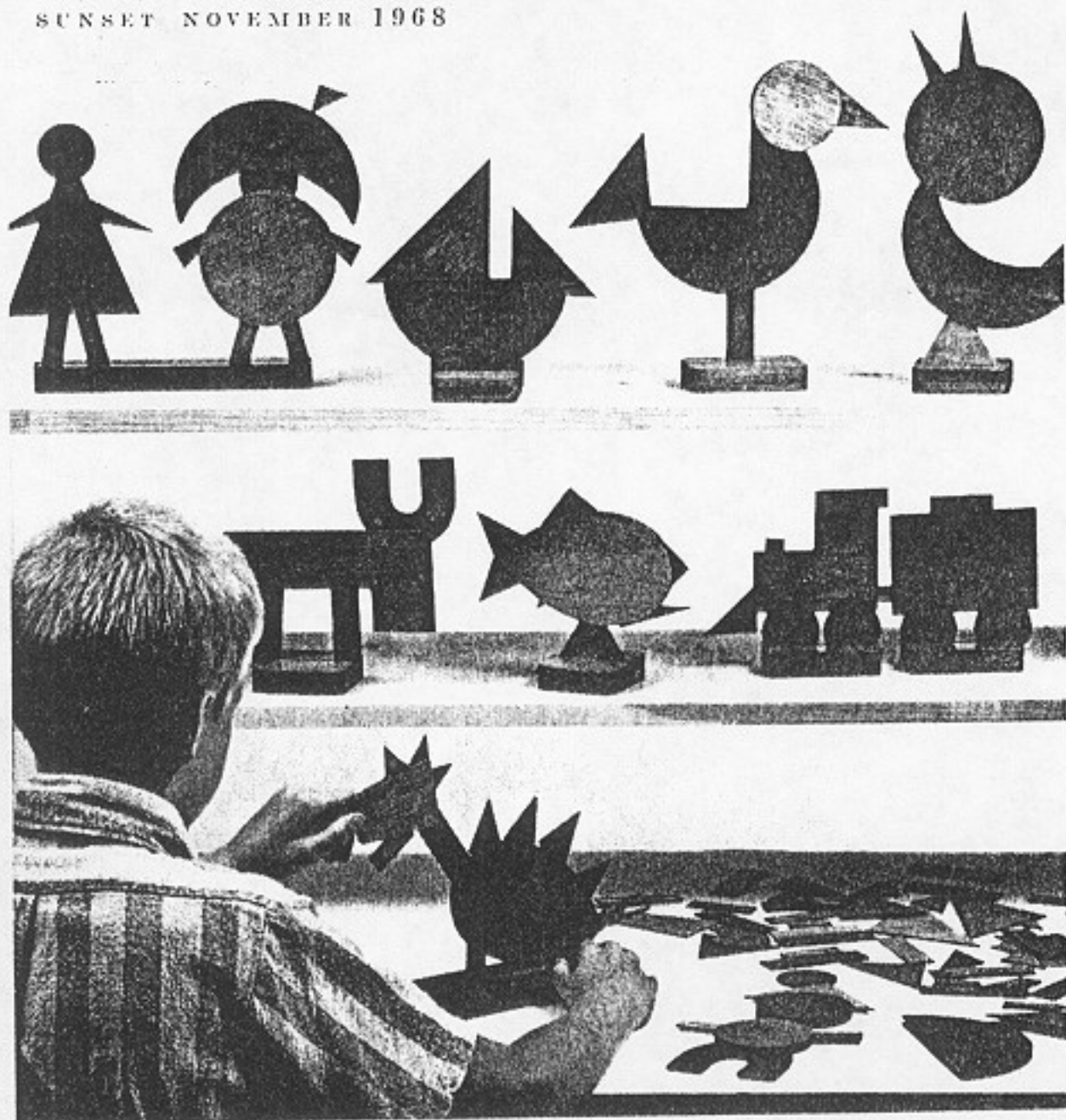
An electric-light circuit will be found much less expensive than batteries for performing electrical experiments. The sketch shows how a small arc light and motor may be connected to the light socket, A. The light is removed and a plug with wire connections is put in its place. One wire runs to the switch, B, and the other connects with the water rheostat, which is used for reducing the current.



Arc-Light Motor and Water Rheostat

A tin can, C, is filled nearly to the top with salt water, and a metal rod, D, is passed through a piece of wood fastened at the top of the can. When the metal rod is lowered the current increases, and as it is withdrawn the current grows weaker. In this way the desired amount of current can be obtained.

By connecting the motor, E, and the arc light, F, as shown, either one may be operated by turning switch B to the corresponding point. The arc light is easily made by fastening two electric-light carbons in a wooden frame like that shown. To start the light, turn the current on strong and bring the points of the carbons together; then separate slightly by twisting the upper carbon and at the same time drawing it through the hole.



Children (and adults, too) can hardly resist making things with these plywood cutouts. This young man is completing a dinosaur, displays some other designs on the shelves

Pre-Christmas cooperation... father makes, son assembles

These delightful, inexpensive toys are little more than a miscellany of pieces of thin plywood. They're excellent training in form and design for youngsters, who simply push the pieces together to form whatever shapes they have in mind. The toys consist of bodies made by sandwiching three pieces of the plywood together as shown on page 115; of single pieces that slip into the bodies; and of bases to hold the resulting shapes upright. Cut the thin pieces from a sheet of $\frac{1}{8}$ -inch lauan plywood (called "door-skin" at lumberyards). A 3 by 6-foot sheet of this thin plywood, costing only \$2 or so, will give you about twice as many pieces as were used to make all the toys in the photograph above.

You'll also need a 4-foot length of 1 by 3 lumber for the bases. Cut a $\frac{1}{2}$ -inch-deep

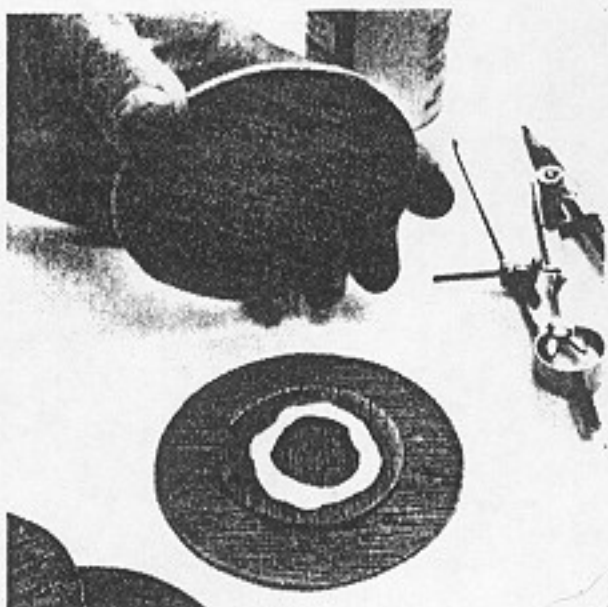
slot lengthwise down the middle of this board with a circular saw (most small circular-saw blades make $\frac{1}{8}$ -inch-wide

slots that will fit the plywood legs). Then saw off pieces of any length for your bases. If you do not have a circular saw available, a lumberyard can cut this slot. Any shapes at all will do for the single pieces and the bodies. We made bodies of disks, half and three-quarter disks, triangles, rectangles, teardrops, trapezoids, and quarter-moons. Make the center piece of each one small enough to leave a $\frac{3}{4}$ -inch-deep slot on all sides. After you glue a body sandwich together, lay it on a flat surface and weight it so the parts will be squeezed together while drying.

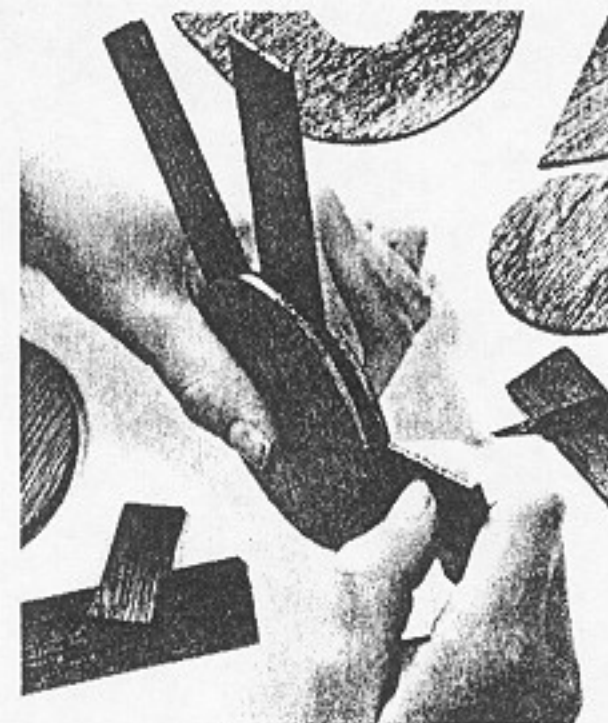
The finish on the toys shown is simply orange shellac, which dries quickly and



A band saw, jigsaw, saber saw, hand scroll saw, even tinsnips will cut this thin plywood. Save scraps for smaller pieces



Each body (or head) is a sandwich of three pieces assembled with white glue. The small centerpiece provides the slot needed



To assemble the toys, you simply push legs, antlers, wheels, smokestacks, or whatever into the slots in the body pieces

helps the pieces stick together. Instead, you could paint the pieces in different colors to make them more attractive to the very young (use non-toxic paint); or

stain the pieces in light and dark tones and then shellac or varnish them.

The simplest way is to shellac or varnish the plywood sheet before cutting it. If

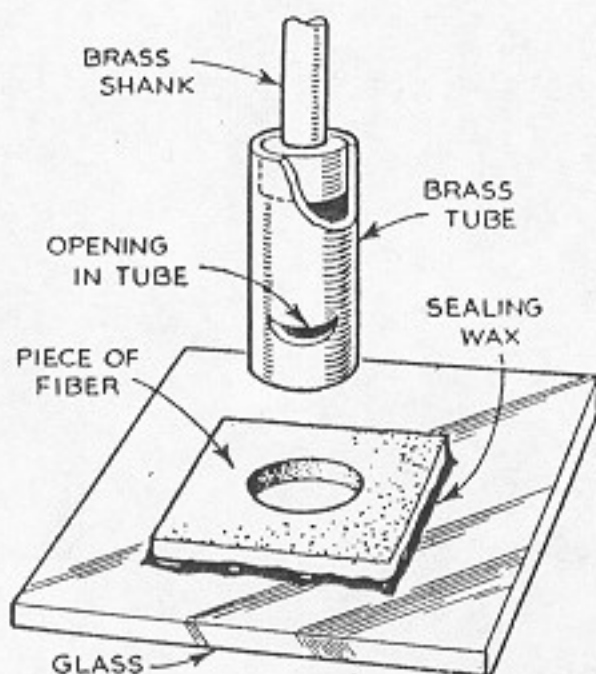
some single or body pieces are a loose fit, just give them a second coat later to make them fit together more snugly.

SOLUTION MAKES GLASS EASIER TO WORK

GLASS may readily be filed, bored, or even sawed with a fine-tooth hack saw if the following solution is mixed for use as a cutting fluid: 2 oz. pulverized camphor, 6 drams sulphuric ether, and enough oil of turpentine to fill a 6-oz. bottle.

To bore holes, first drill and ream a hole of the desired size in a flat piece of fiber, and fasten the fiber to the glass by means of sealing wax with the hole over the correct spot. A short length of brass tubing of the proper size for a running fit in the fiber is provided with a shank to fit the chuck of the drill press. An opening is made in one side of the tube a little above its lower end, as shown. If the bottom of the tube is notched, thick glass can be cut more easily.

Place the glass on the table with the jig attached and with a piece of thin wood or cardboard beneath. About a spoonful of ordinary silicon-carbide abrasive powder is then poured into the opening in the side of the tube after the tube has been lowered to the top of the fiber. Start the press slowly and pour



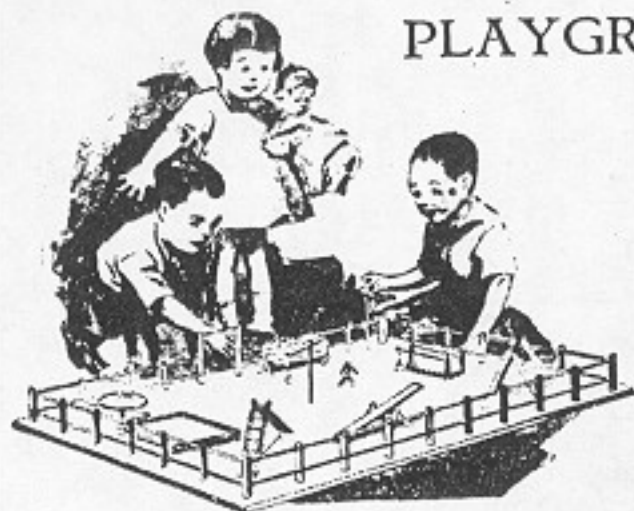
Glass-boring tool with opening through which the abrasive and cutting fluid are injected

some of the special solution in through the hole as the boring begins. In a surprisingly short time, the hole will be ground through. When the tube is removed, a blank of the glass will be found inside, and the opening in the tube enables it to be pushed out from above. Disks of any size may be made in this way for microscope work, lenses, and the like.

Large show windows that are cracked are sometimes temporarily repaired by drilling a hole in the glass and applying washers or a brace behind the fracture. To drill such a hole, use the cutting tube in a small breast drill. Fill the tube about one-third full of the solution and abrasive material, and cover the opening with tape.

In model work it is sometime desirable to fit irregular places with glass, and this may be easily accomplished by wetting a file with the solution—a bastard file for thick glass and a mill file or similar cut for thin. To saw glass, place a thin board on each side of the piece to be cut and use a slow stroke, keeping the fine teeth of the blade wet with the solution.

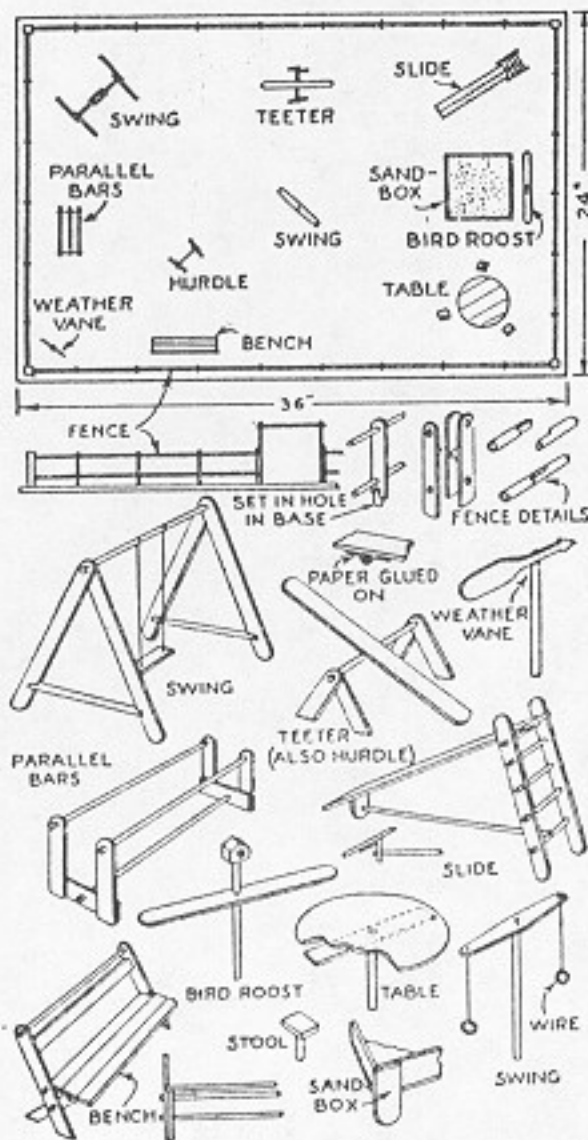
PLAYGROUND IN MINIATURE



Doll houses and farmyards are old favorites, but here is something new—a toy playground

MINIATURE toys, such as the realistic little playground illustrated above, have a strong appeal for the younger children, particularly if they can shift around the various objects to suit themselves and really play with them.

The playground apparatus, table, bench, stools, weather vane, and sand-box can be made easily from scraps of cardboard, lollipop sticks or similar round sticks, and a few thin, flat sticks of the type used as handles for various ice-cold confections sold to children. A supply of these, a little glue, some string, and a piece of 2 by 3 ft. fiber wall board for the base are the only materials required; and for tools it is sufficient to have a razor blade, pocketknife, small hand drill, ruler, and pencil. Paint the apparatus with quick drying enamel or other glossy finish.—D. W. C.



Plan view giving a suggested layout of the playground, and drawings of the equipment

HOW TO CUT SAFETY GLASS

POPULAR SCIENCE MONTHLY SHOP DATA
1943

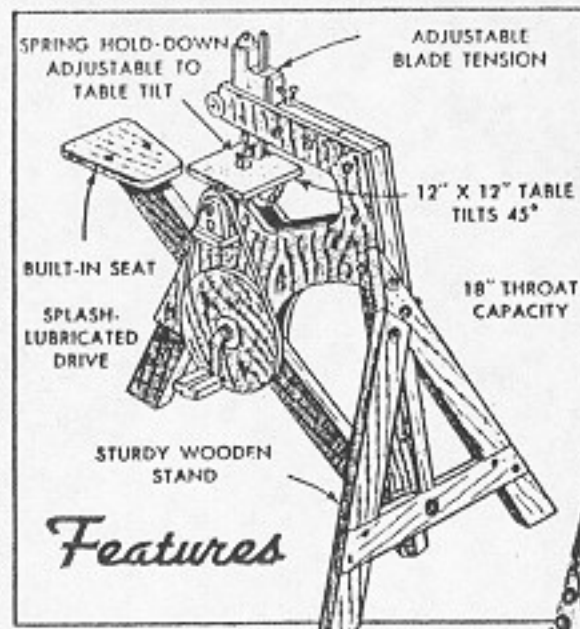


Steps in cutting safety glass like that used on automobiles are as follows:

1. Score the glass along one surface in the usual way with a glass cutter.
2. Lay the glass on a table with the scored line on top and directly above the table edge.
3. Place one hand on each side of the scored line, and press down on the overhanging part until you see or hear the glass crack along the cut. Or you can secure one section with a board and two C-clamps, and press on the overhanging portion with both hands.
4. Turn the glass over and score a second line exactly opposite the first.
5. Repeat steps 2 and 3 to break the layer of glass on the second side.
6. Work the glass back and forth to break the plastic sheet at the center. If it doesn't part readily, lay the glass over a small stick or rod, weight down the two sections to spread the cut, and separate the plastic sheet with a thin razor blade.

To cut "chicken-wire" glass, simply score one surface, and break in the usual way. The embedded wire snaps off readily.

Foot-powered SCROLL SAW



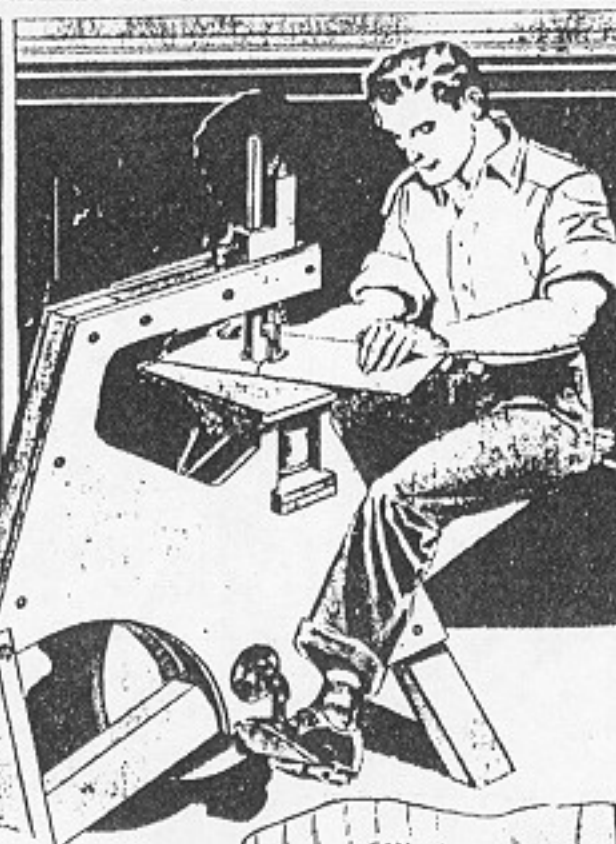
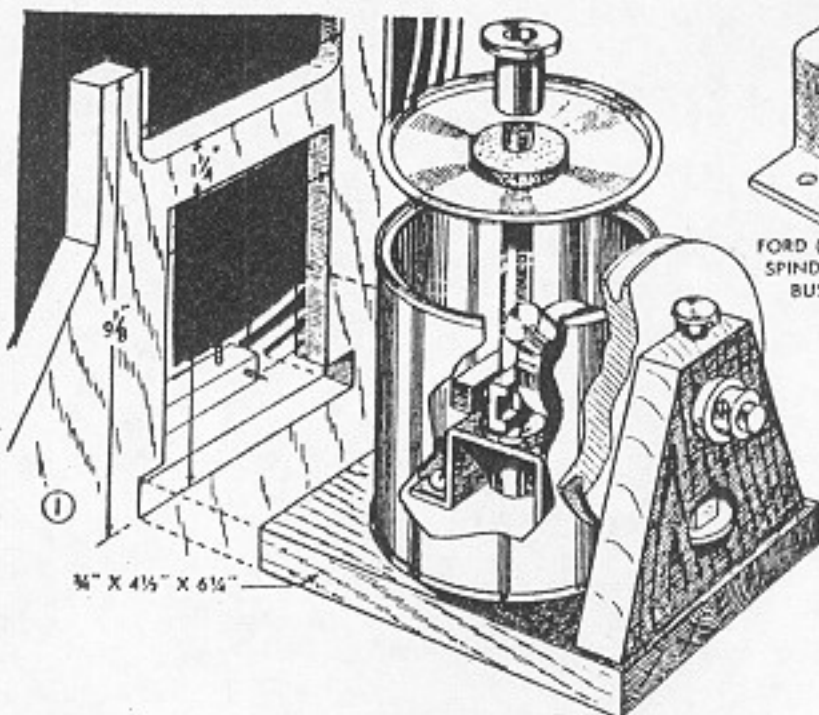
Although designed to be pedaled like a bicycle, you can use a motor to run this sturdy scroll saw. It is built almost entirely of wood, has splash-type lubrication, adjustable blade tension and other features as shown above.

POPULAR MECHANICS APRIL, 1943

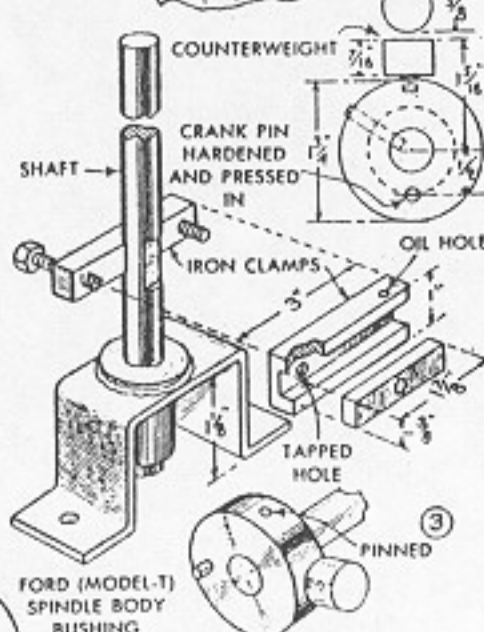
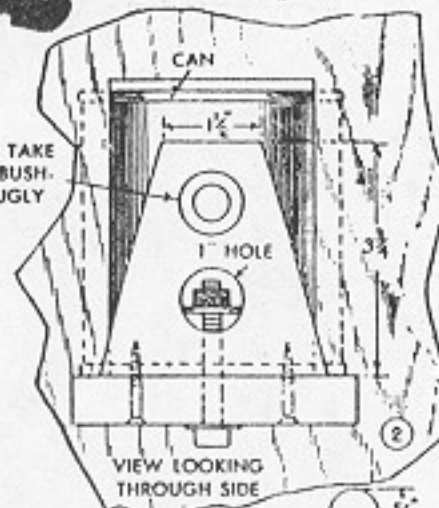
By Wayne C. Leckey

PART I

SCARCITY of metal need not keep you from having a scroll saw, as this one is made mostly of wood. Aside from the bolts and bushings required, the few other pieces of metal needed can be salvaged, in most cases, from odds and ends found in the junk box. If plywood is not available in your particular locality, you can resort to solid stock by gluing up panels of sufficient width. The crankshaft mechanism of the drive head operates in a bath of oil and is sealed inside an ordinary 1-qt. paint can of the type having a press-fit lid. Fig. 4 will give you an idea of how it works. A crankshaft, entering the side of the can, engages a bar, which slides back and forth in a channel clamped to a vertical shaft.



HOLE TO TAKE SPINDLE BUSHING SNUGLY



This produces a smooth reciprocating motion of the shaft, much like a piston, the stroke being 1 in. Oil in the bottom of the can is splashed by the crankshaft to keep the mechanism well lubricated.

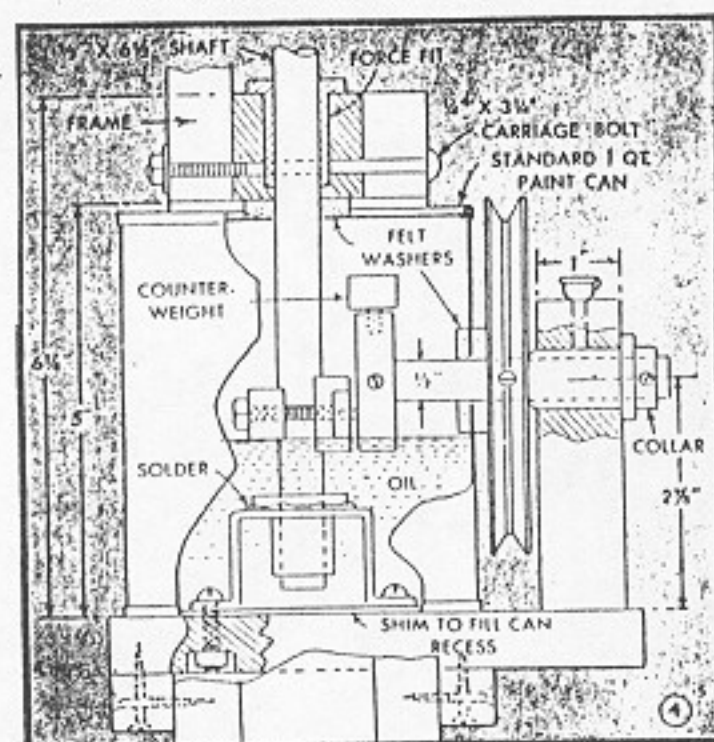
The complete drive unit is shown in Fig. 1, partly cutaway so that you can get a better idea of its assembly. Bronze spindle bushings (Ford model-T type) are used as sleeves for the vertical shaft and also as a bearing for the crankshaft. Fig. 3 shows how the channel is clamped to flattened places on the shaft, and how the lower bushing is mounted in a flat-iron bracket. Note from Fig. 4 that the bolts in the latter fasten both it and the can to the wooden base. You can work the channel to shape by hand using a hacksaw, chisel and file, or you can have the channel and crankshaft made. Thick felt washers prevent leakage of oil at points where the two shafts pass through the can. The oil level, of course, should be kept below the hole in the side of the can, as shown in Fig. 4.

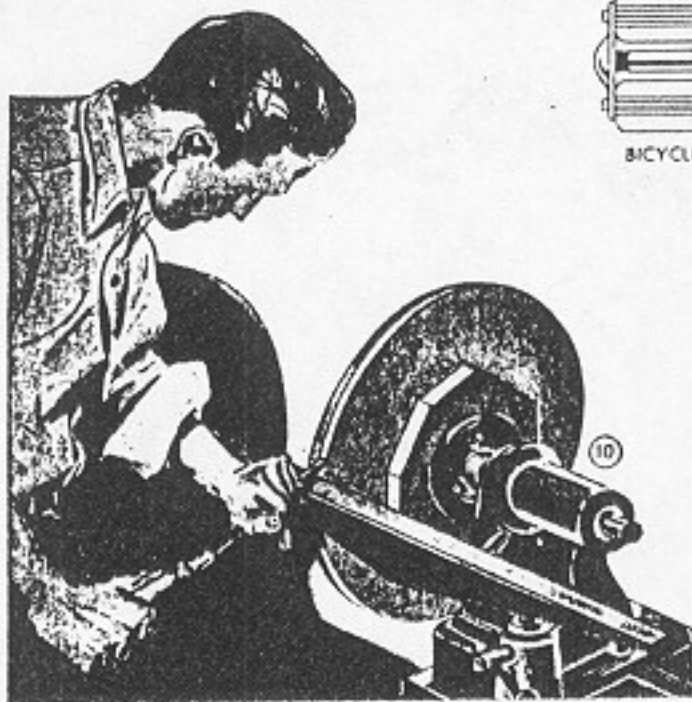
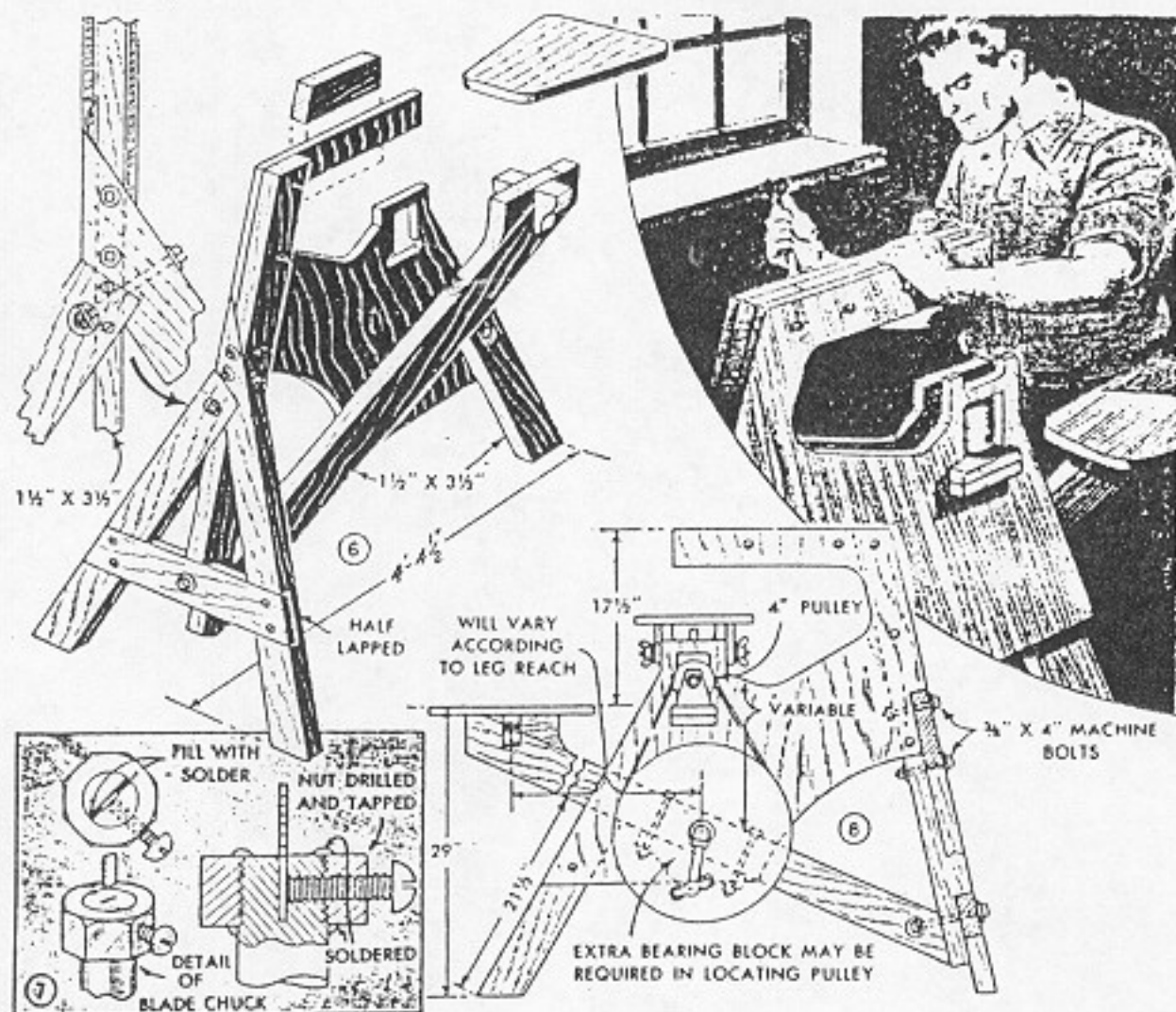
It is important that the block holding the crankshaft bearing be rigid. Fig. 2 shows a way of bolting

this, which allows it to be retightened easily if it should work loose. When installing the crankshaft there must be no end play, as the face of the disk, bearing slightly against the channel, keeps the bar engaged in the latter. It also prevents twisting of the shaft and saw blade, which would cause the latter to break. So, see that the set-screws in the pulley and the collar are tightened securely to the shaft on each side of the bushing, without side play. If desired, you can make the pulley of wood and pin it to the shaft. Before the lid can be pressed on the can, the upper end of the shaft must be threaded and slotted, so that a blade chuck like the one detailed in Fig. 7 can be fitted to it after the upper bushing and the filler block in which it

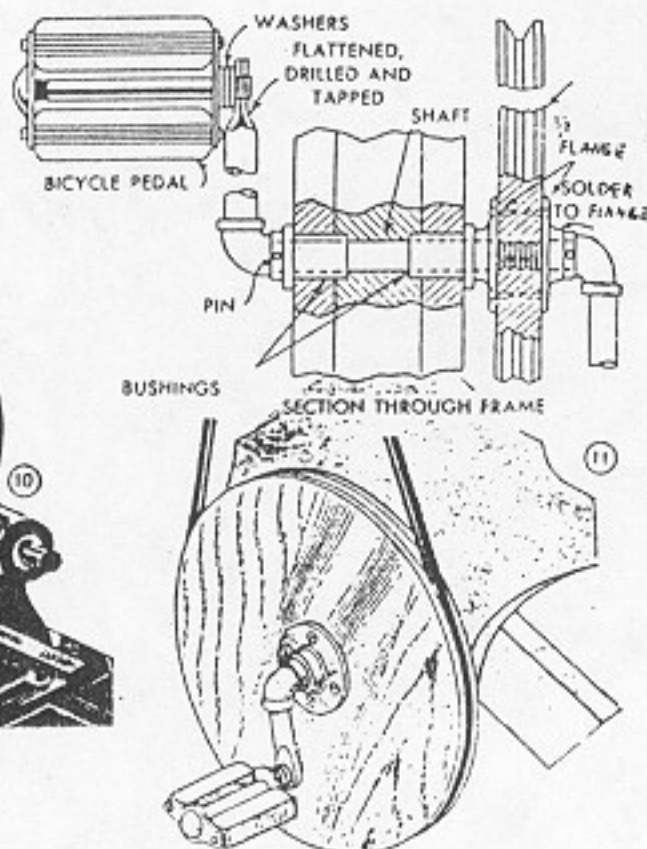
fits, have been slipped over the end.

You can set the drive-head unit aside for the time being, and proceed to make



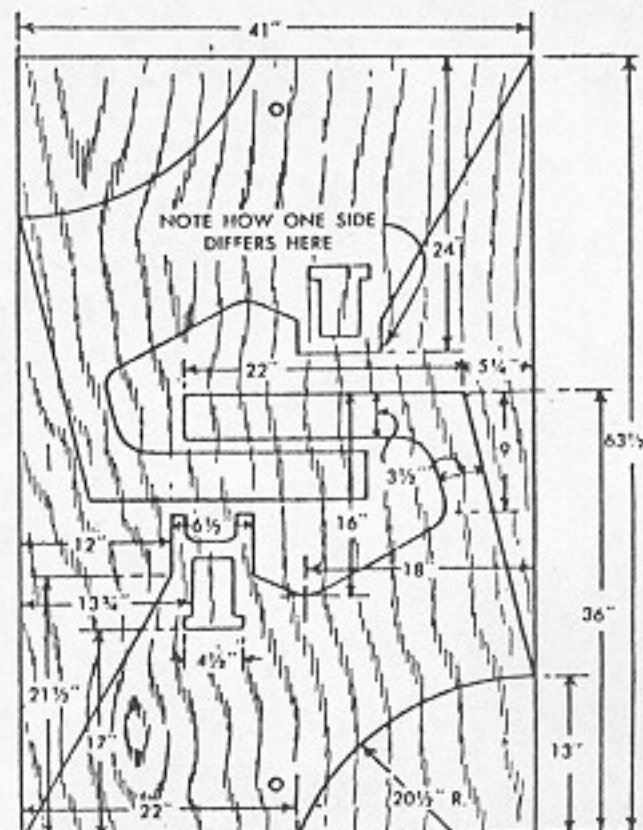


the wood stand. Plywood is preferred but solid stock can be used. Fig. 9 shows how both side pieces can be laid out economically on a 41 by 63½-in. panel, after which the two can be cut apart roughly with a compass saw and then trimmed to exact size. The size of the opening in which the drive head fits is given in Fig. 1. Note that the left-hand side has projections above the opening, which serve as stops for the tilting table. The frame or core to which the side pieces are glued and bolted is made up of common 2 by 4-in. material. Fig. 6 shows the arrangement of the pieces, while Figs. 5 and 8 detail how the rear legs are fastened rigidly with bolts and screws. The member which extends to form a seat is bolted to the front and



rear legs in the same way as used in the drive head. As individual leg reach varies, the length of this piece will have to be determined by trial. This is likewise true in locating the bearing hole for the large drive pulley. For some persons it may be satisfactory if centered in the seat member as in Fig. 8; for others it may be necessary to fit an extra block as indicated to permit lowering the position of the pulley to a point where it is easy to pedal.

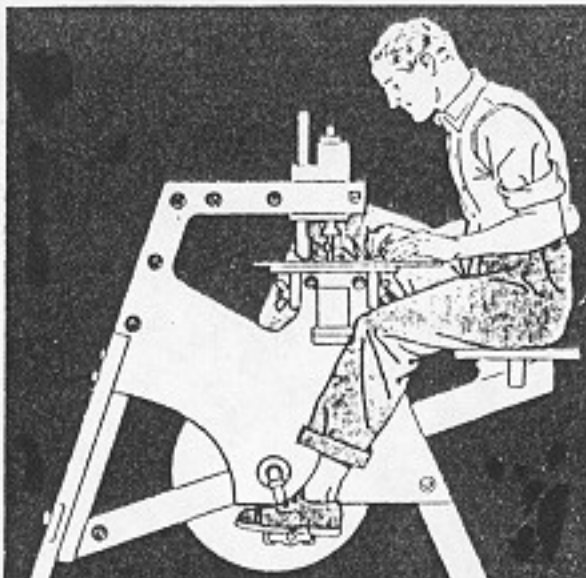
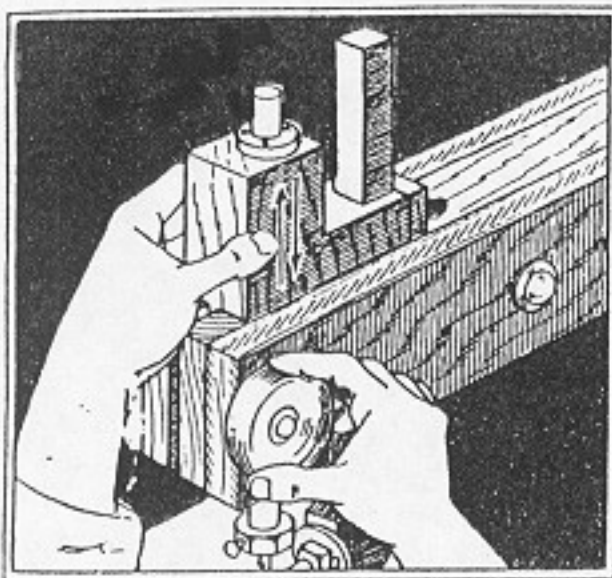
Assemble the stand as far as shown in Fig. 6 and then slip the drive unit into the opening provided for it before putting the opposite plywood side on the frame. This



9 HOW SIDES CAN BE LAID OUT ECONOMICALLY

of course, will necessitate removing the pulley and the wood bearing block. In doing this, be careful that the pin in the crankshaft does not disengage the bar. Cleats are used in the manner shown in Figs. 1 and 4 to fasten the drive unit in place, after which the filler block containing the upper bushing of the shaft is bolted flush with the top of the plywood sides. With this filler block in place, you can go ahead and add the blade chuck to the slotted end of the shaft. This consists of a hexagon nut screwed and soldered to the end and then drilled and tapped crosswise for a setscrew to clamp the blade as shown in Fig. 7. The blade can be made self-centering in the chuck by filling the slot with solder on each side of a piece of wood that is the same width as the blade.

The sectional view in Fig. 11 shows how the large drive pulley is held to a ½-in. pipe shaft by two floor flanges which are centered and screwed opposite each other. One end of the shaft is threaded to pass through the flanges far enough to permit a ½-in. elbow to be pinned to the projecting end and soldered to the flange. If you are unable to have the bushings turned of metal to fit the pipe shaft, satisfactory ones can be turned of hard maple and replaced at signs of wear. If metal bushings are used, they should be a press fit in the stand. Bicycle pedals attached to flattened ends of short pipe arms make a neat job. Owing to the size of the plywood drive pulley, you'll have to true it on the outer end of the lathe as shown in Fig. 10.

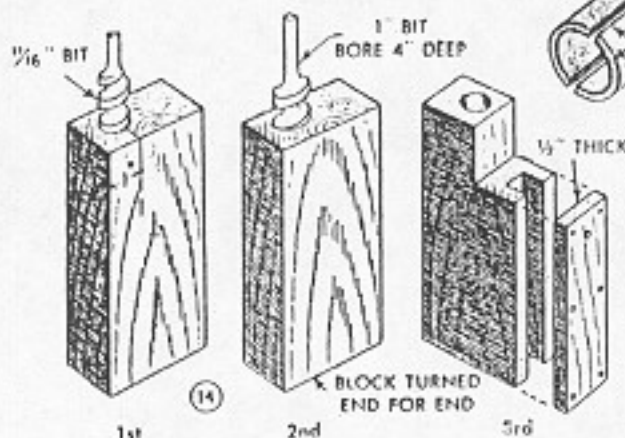


Foot-powered SCROLL SAW

By Wayne C. Leckey

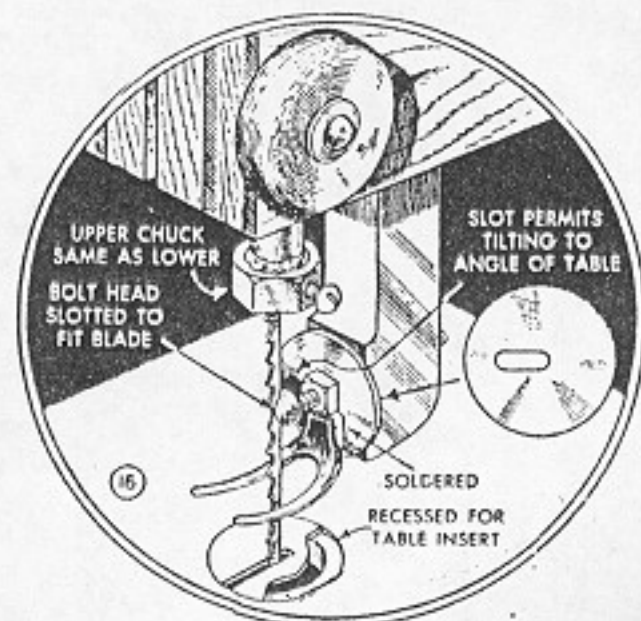
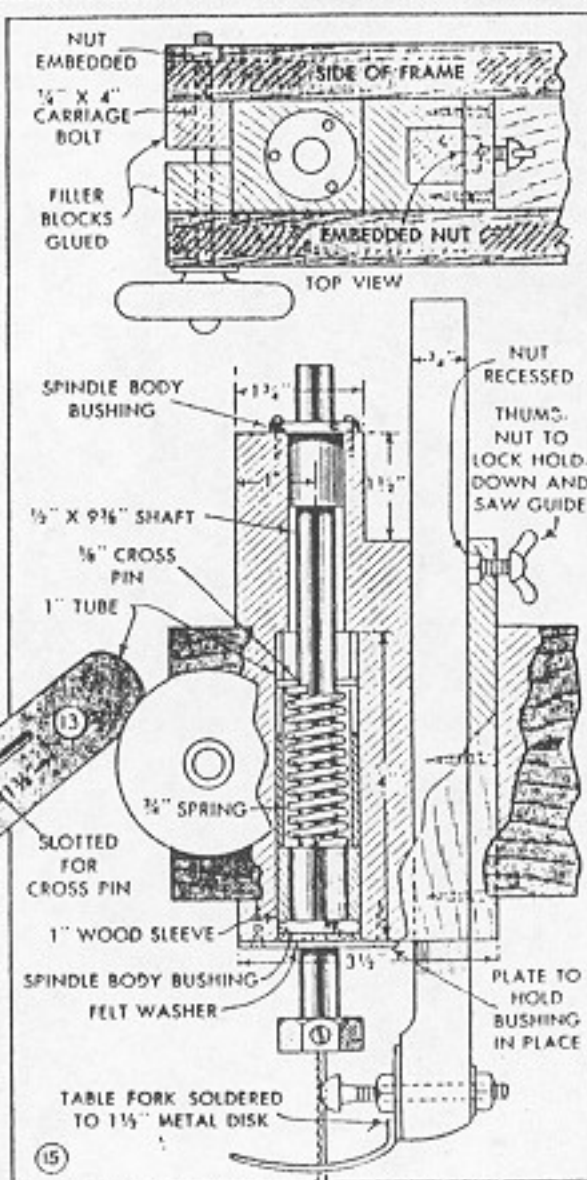
PART II

CONTINUING construction of your foot-powered scroll saw, you make the blade-tension unit, Fig. 12, next. This is adjustable up and down in the arm so that the tension on the blade can be varied to suit the size being used and thereby reduce breakage. A record of the tension found best for each blade can be indicated on the side of the unit by marking on it across the top of the frame. These calibrations will tell you how much to raise or lower the unit when changing to a finer or coarser blade. Fig. 14 gives the steps in making the wooden housing of the unit. You begin with a hardwood block $1\frac{1}{2}$ by 3 by 7 in. A line is drawn down one side and across both ends to mark the points for boring.

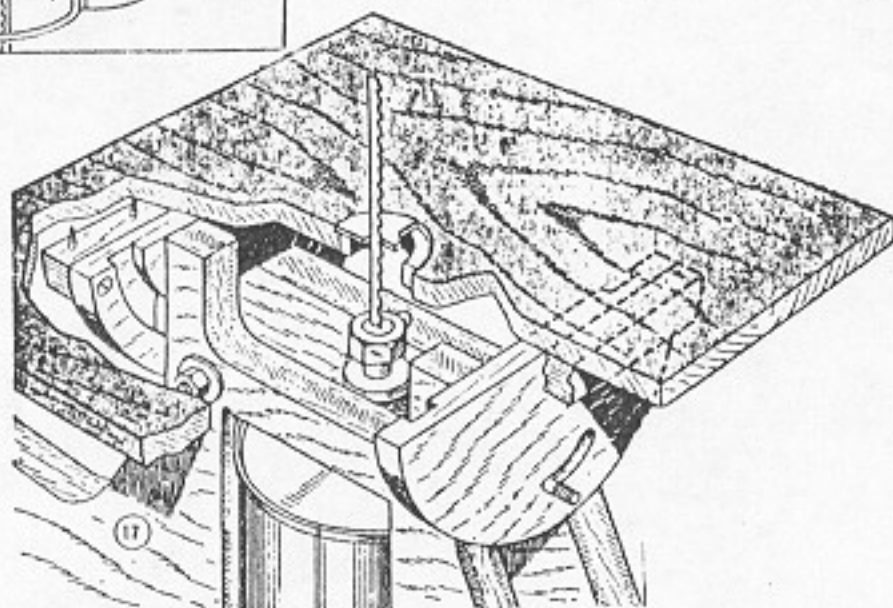


As it is important that the holes be in line centrally through the block, a drill press is preferred to boring them by hand, although the latter can be done fairly accurately if you are careful to keep the bit running as straight as possible. Bore the top hole 3 in. deep, then turn the block end for end, and with a 1-in. bit, bore through to meet the first hole. Next, groove the rear edge of the block to take the hold-down, after which the upper corner is notched according to the dimensions given in Fig. 15.

The cutaway sectional view in Fig. 15 shows what the tension mechanism looks like when installed in the counterbored



housing. Bronze bushings of the type that were used in the drive head are used here to carry the shaft; the upper bushing being pinned to the block through the flange and the lower one bushed centrally in the hole with a turned wooden sleeve. Fitting the lower bushing is done after the large hole is lined with a 1 by $2\frac{3}{4}$ -in. metal or Bakelite tube, slotted like the one shown in Fig. 13. This tube, besides forming a well for grease to lubricate the spring and lower bushing, keeps the shaft tracking without twist by engaging a cross pin in the shaft in slots in the tube. Needless to say, the slots in the tube must be cut down each side exactly in the center, otherwise the pin is apt to bind or prevent assembly. The shaft, with the cross pin either threaded or pressed into it, must be slipped inside the tube and both inserted in the hole at the same time, after which the spring is added and the lower bushing and its sleeve are pressed in the end to hold the tube in place. The width of the slots in the tube should equal the diameter of the cross pin. Note that a thick felt washer is provided between the bushing and the metal plate which holds the former in place, to prevent oil from being thrown out through the shaft clearance in the plate. The upper blade chuck is made the same way as the lower one, which was described previous-

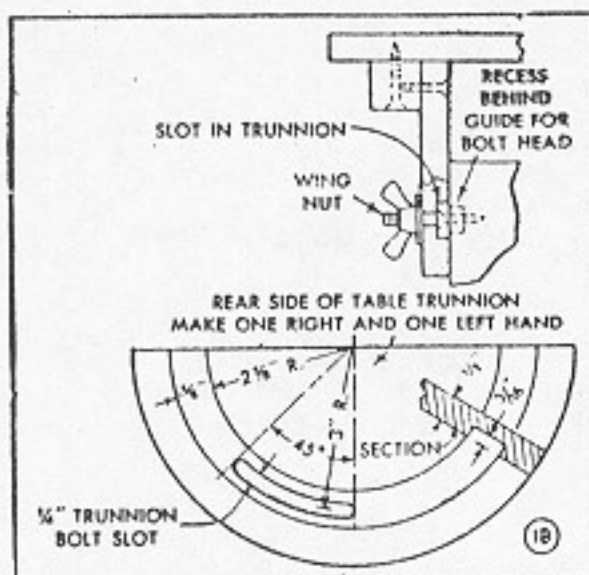


ly, the end of the shaft being threaded for the nut before the shaft is installed in the housing.

A turn of a handwheel clamps the unit securely in the arm. This can be made of wood and fitted with a carriage bolt to engage an embedded nut in the opposite side as shown in the top view of Fig. 15. The completed unit must be mounted in the arm so that the upper chuck will be directly in line with the lower one. You can do this best by clamping the unit temporarily in place with a C-clamp or a handscrew and checking it for alignment with a square held along the underside of the arm. When centered, the frame core piece along the top of the arm is fitted and bolted in place behind the unit and filler blocks or stops are glued between the sides at the front. See top view, Fig. 15.

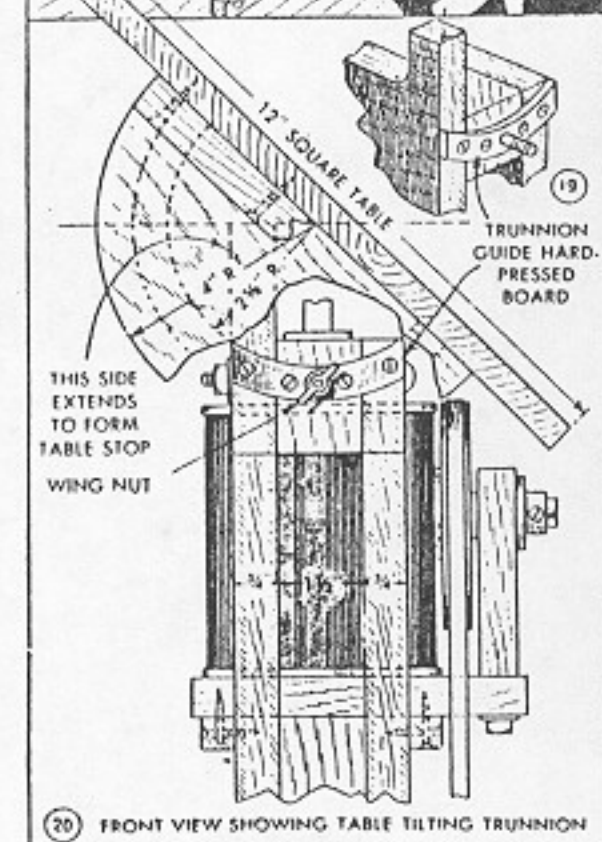
The work hold-down, Figs. 15 and 16, is improvised from an old table fork having the two center lines removed. It is soldered to a 1½-in. disk slotted crosswise, to permit the hold-down to be adjusted to whatever slant the table may be tilted. The fork and disk are held to a wood shaft by a bolt blade guide. Several of these guides will be needed to accommodate blades of various thicknesses. You can make them easily from ¼-in. carriage bolts by slotting the heads the required depth with a hacksaw and then closing the slot slightly by peening it to suit the blade thickness. A thumbnut fitted as shown in Fig. 15 serves to lock the hold-down at the desired height, and wax applied to both the shaft and the channel in which it moves will make it slide easily.

Making the trunnions for the tilting table will require the use of a lathe, as a groove must be turned in them to take guides on which they move. Both trunnions can be had from one plywood disk by sawing it carefully in half after turning to size. Note in Fig. 18 that the bolt slots through the trunnions must be cut on opposite sides of the centerline to obtain right and left-hand units. Use hard-pressed



board from which to turn a ring to fit the trunnion grooves nicely and then screw 3-in. segments of the ring flush with the top of the frame at the front and back as shown in Figs. 19 and 20. Notice that the square heads of the trunnion bolts are embedded under the guides before screwing the latter in place. A wing nut and washer are provided on each bolt to lock the trunnions in position. Wax applied to the trunnion grooves and the guides will make the table tilt smoothly. Plywood is preferred to solid stock for the table, as it will stay flat. It is attached to the trunnions with cleats as shown in the upper detail in Fig. 18. You will have to do this, of course, while the trunnions are in place on the guides. The recess for the metal table insert is formed easily by pressing a turned ring in the hole as shown in Fig. 17. Here you also can see how the frame extensions provide stops to permit returning the table quickly to a horizontal position. Where it is desired to have the table so it can be tilted 45 degrees to the left also, the stops can be cut off. With this arrangement, the clamping-bolt slots are extended and the trunnion indexed 90 degrees for rapid setting.

If you are unable to buy an endless V-

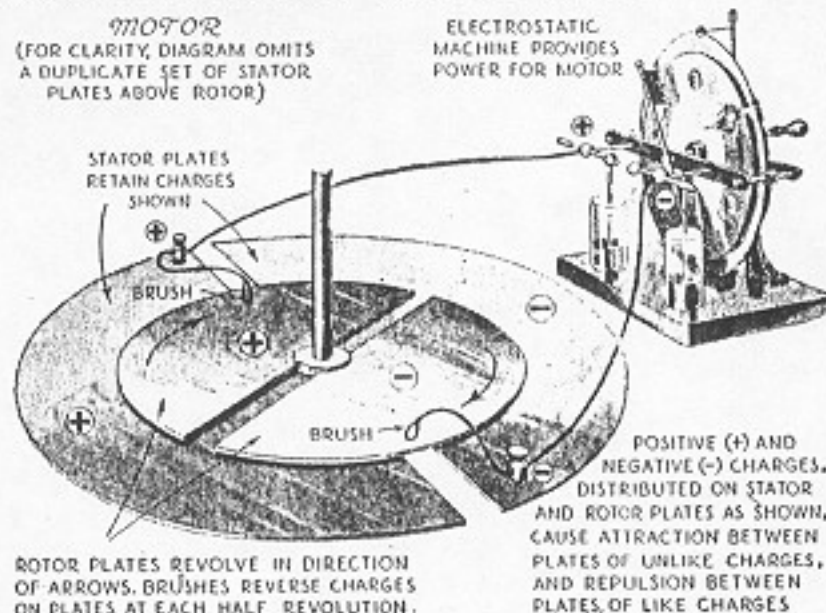


belt long enough to reach the drive pulley, you can resort to round leather belting or even sash cord, applying belt dressing if slippage develops.

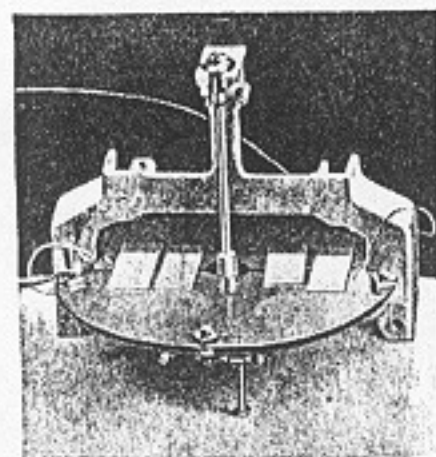
Popular Science Monthly AUGUST, 1935

NOVEL MOTOR OPERATES ON STATIC ELECTRICITY

A MOTOR that runs on static electricity is an electrical novelty constructed by a Morris, Minn., experimenter. Forces of attraction and repulsion operate as in conventional motors, except that an electrostatic field replaces the usual electromagnetic field. When power is supplied by a static machine of the type found in high-school laboratories, the rotor spins at 200 revolutions a minute. If the motor is connected, instead, to an antenna and the ground, it will run on atmospheric electricity during a storm. The builder suggests that such a motor might find practical application in a meter for measuring static electricity in the atmosphere.



The odd motor pictured below runs on static electricity. The diagram at left shows how an electrostatic field provides the motive power

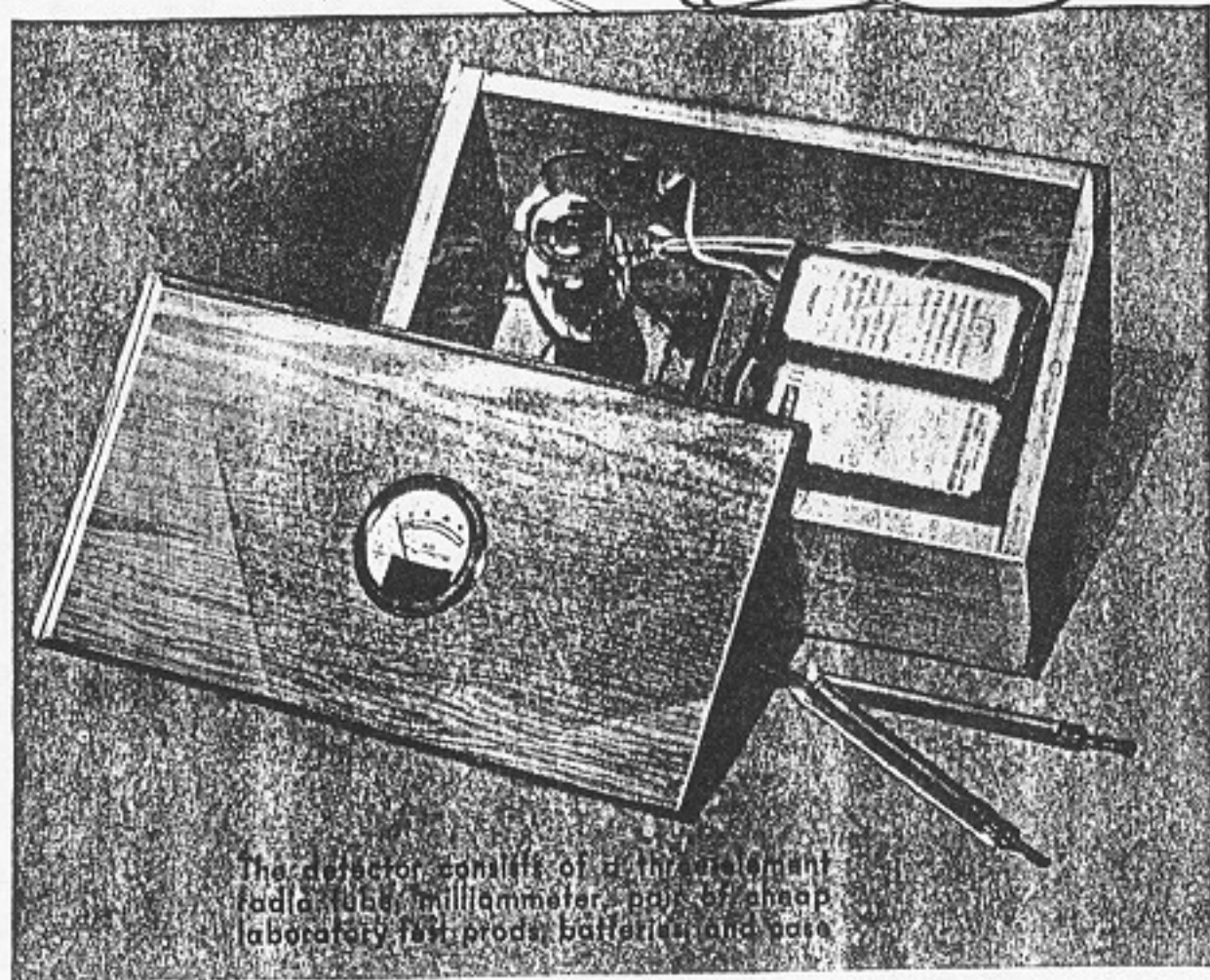


ELECTRIC LIE DETECTOR

... A NEW FUN-PROVOKING
STUNT FOR PARTIES



GIANT HOME WORKSHOP MANUAL
1941



The detector consists of a three-element radio tube, milliammeter, pair of cheap laboratory test prods, batteries, and case.

WITH this homemade electric lie detector, you can mystify and entertain your friends by exposing falsehoods. Hundreds of tests by the writer have proved its meter to indicate correctly about eighty percent of the time, and that is sufficient to get a lot of laughs at any party.

The cost need not exceed \$2.50. A three-element radio tube (No. 45) is used in the circuit. The other parts required are a socket, 45-volt "B" battery with a 22½-volt

tap, two 1.5-volt dry cells (connected in series), two cheap laboratory test prods, and an inexpensive milliammeter. A 0-15 milliammeter was employed for the detector shown, but one with higher readings is preferable because the readings are often near the 15-milliamper mark. A small rheostat can be placed in series with the milliammeter to reduce the readings, if preferred.

The parts may be mounted in any convenient way provided the connections are

made as shown. It pays, however, to design the box or cabinet so as to look as impressive as possible for its psychological effect.

The 45 volts applied to the plate of the tube through the milliammeter are enough to produce a current reading of about 10 milliamperes. By holding one of the test prods in each hand, the subject connects the 22½-volt tap of the battery to the grid of the tube. As the pressure of the hands upon the test prods increases, the resistance at

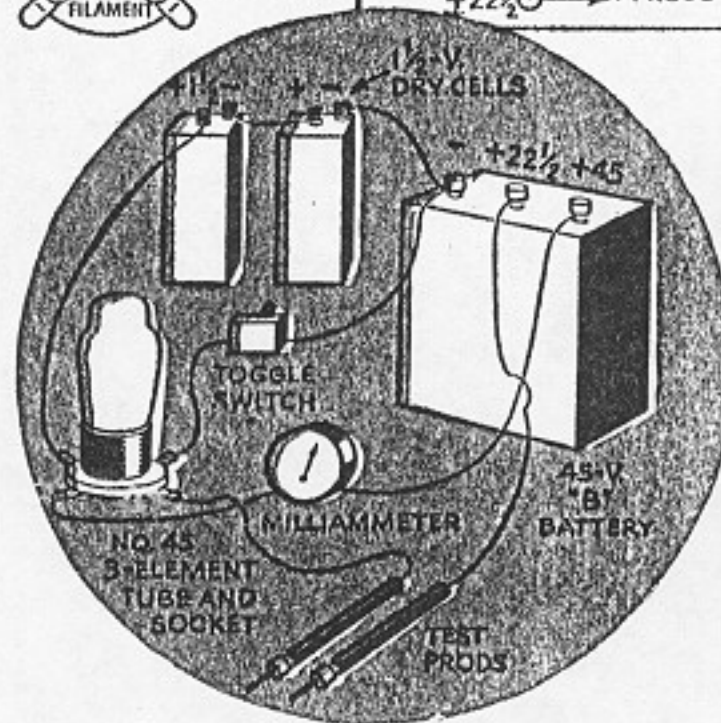
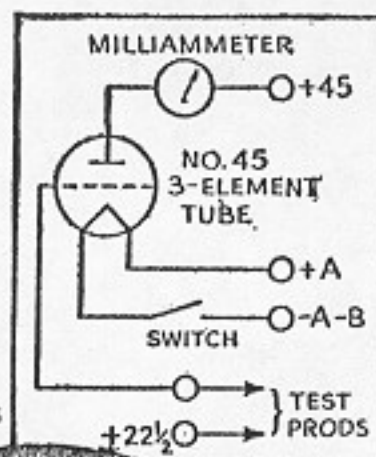
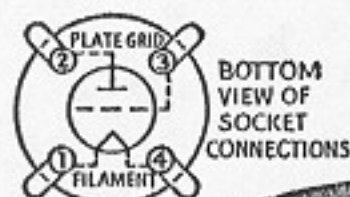
this point decreases, thus permitting a greater flow of grid voltage. This causes a higher milliamperere reading, which indicates increased tension on the part of the subject.

Not the slightest hint as to how the detector works must be given to the person being tested. He or she should merely be instructed to hold the metal end of a test prod in each hand with a light, comfortable grip. The box should face the questioner so that the other person cannot see the reading of the milliammeter.

One way of using the device is to tell a man to write down the names of five girls, including that of his wife or sweetheart. He is then to answer "No" to each question, such as "Is it Ruth?", "Is it Grace?", and so on. Involuntarily he will grip the test prods tighter when he says "No" to the right name. Another idea is to have the subject hide an object somewhere in the house, unknown to you. Then name the different rooms to him and watch the dial as he says "No" to each question.

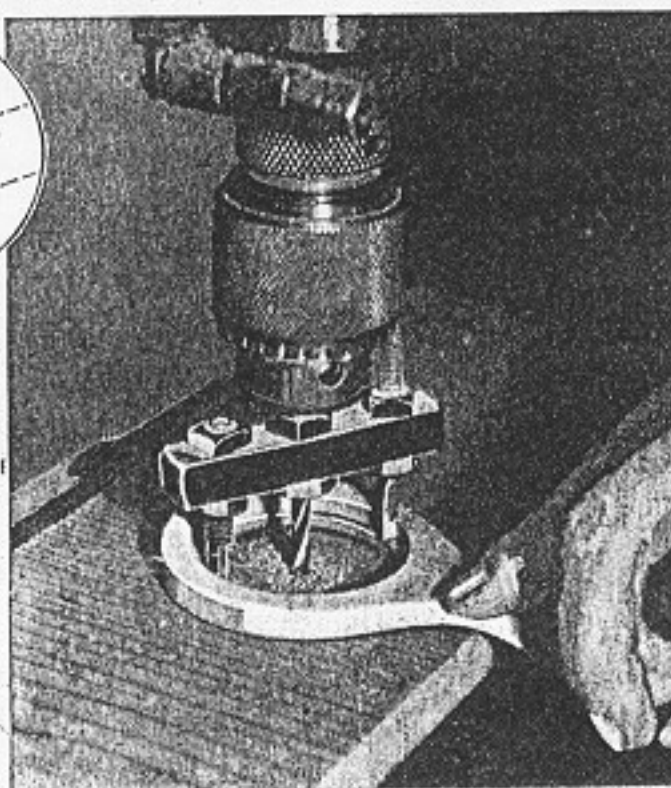
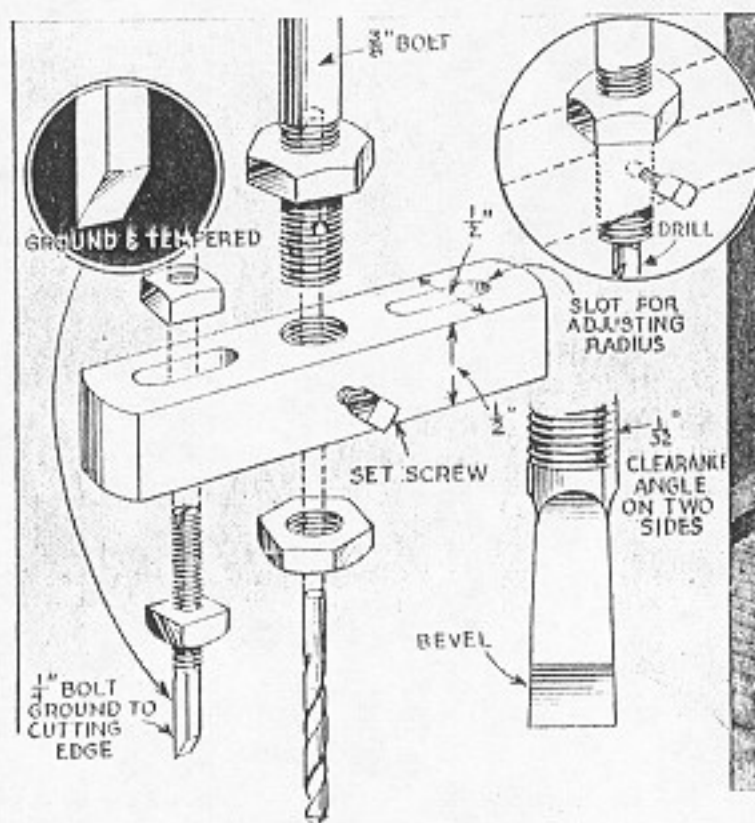
Other similar experiments can easily be devised. Bear in mind that the questions should be planned in advance and asked fairly rapidly so as to catch the subject unawares and startle him sufficiently to make him grip the prods tighter in his effort to control himself and lie convincingly.

The wiring diagram is given at the right, and the connections are shown pictorially in the drawing below



POPULAR MECHANICS APRIL 1939

Boring Tool Adjusts to Varying Diameters



Originally designed to bore out wooden frames for magnifying lenses, as shown in the illustration, this boring tool has the distinct advantage of being adjustable for a 1-in. variation in diameter. There are two cutters, one running slightly deeper than

the other. They are simply machine bolts with the heads cut off and the ends ground with bevel and clearance angles as shown. Hardening and regrinding to a sharp edge will make them suitable for use in any wood and also very soft metals.

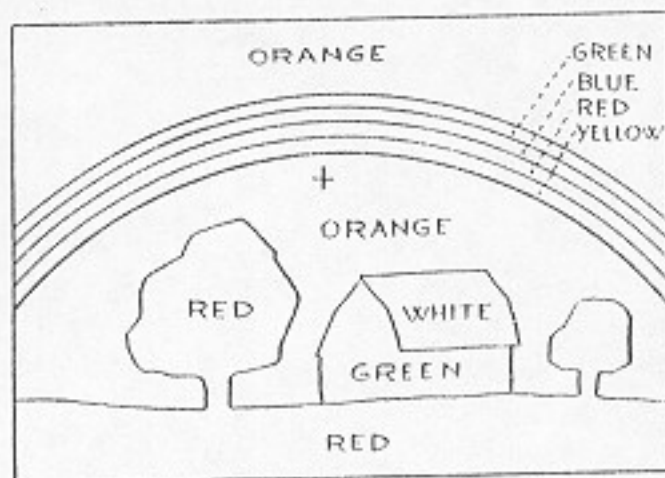
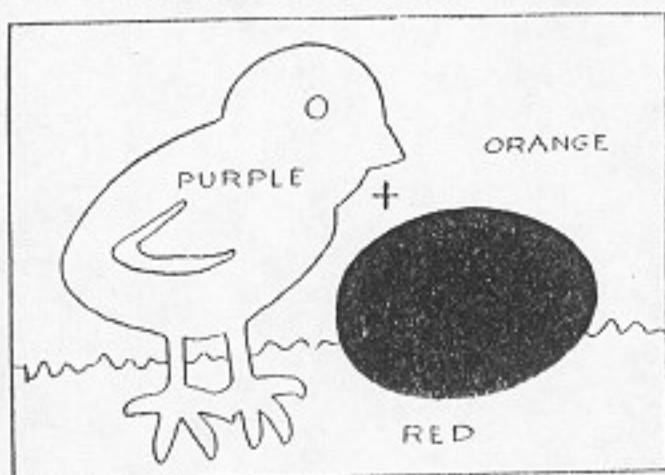
Seeing GHOSTS

NOW EXPLAINED BY
SIMPLE EXPERIMENTS

POPULAR SCIENCE MONTHLY November, 1933



Holding it in a bright light, look fixedly at a piece of white paper upon which you have drawn and colored the figure seen at left. Then when you look at the wall, its ghost appears with hood green and the skull white



If you trace on white paper, and color as indicated, the figures shown in the illustrations above, you can see them as ghosts on the wall, each object appearing as a dimly-seen figure in its complementary colors

GHOSTLY, sheeted figures, seen as one runs past a dark cemetery, are not merely figments of the imagination. They are actually seen as real ghosts looming out of the night.

This is the conclusion arrived at by psychologists who now claim that people really see with their own eyes the apparitions that form the bases of "true" ghost stories.

According to these psychologists you can, at will, see synthetic specters, in the following manner:

To see a white skull, covered with a green hood, trace the outlines of the skull, which is seen on this page,



on writing paper with a pen and jet black ink. Fill in the black parts carefully and then with wax crayon or water-color, make the hood red.

To see the ghost, hold the drawing in the light of a white electric bulb and stare steadily at the skull's nose for fifteen or twenty seconds. Then, quickly looking away, stare fixedly at a white, dimly lighted wall.

In two or three seconds, you will see a pale green hood appear, to be followed by a white skull. After three or four seconds, the vision will fade away.

The green color on the ghost's hood is due to the fact that prolonged staring at the red hood tired the retina so it became temporarily less sensitive to red. As a result, when you look at the wall, the retina responds only to the red's complementary color—green.

Similarly, the black skull rests the retina and makes it more sensitive to the reflected light from the wall, which accordingly shows you the black pattern in the white, ghostly outlines of a specter.

Now trace off and color the outline of the two pictures seen in the first columns.

After being looked at steadily for a few moments, the ghosts of the pictures will appear on the wall as a yellow chicken, white egg, green ground, and blue sky. The other figure will show a green tree, red barn, and the rainbow in its correct order of colors.

Psychologists have proved that these after images can, occasionally, be retained by the retina for a surprisingly long time. For example, let us suppose that one who was frightened by the graveyard spook had recently seen a human figure silhouetted in black against a lighted doorway. Experiments show that it would be possible for him to carry this after image in his eyes and to see the same figure as a white ghost against the dark trees.

One experimenter saw the after image of an object on the wall of his room on awakening from a whole night's uninterrupted sleep. This makes it easy to explain how people wake up and see ghosts moving about their rooms, leaning on the foot of their beds, or peering in at the windows. Each ghost is the after image of some person who may have been seen against a strong light several hours before.

Another interesting experiment explains the type of ghost seen when one carries a candle about in a dark house.

Hold a lighted candle two or three inches before your nose and move it slowly from side to side. In a short time you will see the network of finely branching blood vessels on your eye's retina, outlined against a dull, red background. Also you will see near the center a light spot. This is the fovea, or point of most distinct vision.

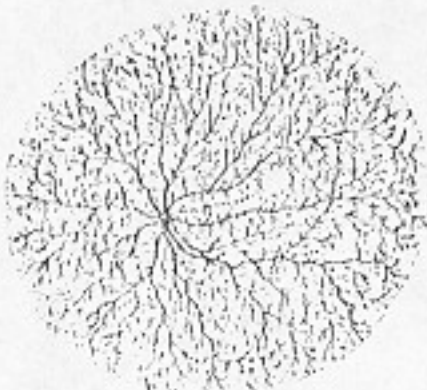
How easy it would be for an apprehensive person carrying a candle or small lamp, to perform this experiment unconsciously and to mistake

the fovea for a dimly seen head with some of the blood vessels forming the folds of a cloak. Doubtless this is the secret of the ghosts seen in old "haunted" houses.



CREATING A GHOST

Looking steadily at a moving candle will give you an image of the eye's retina and fovea, as seen at right. The fovea is the white dot. Seen in a dim light, the fovea and retina may become a ghost

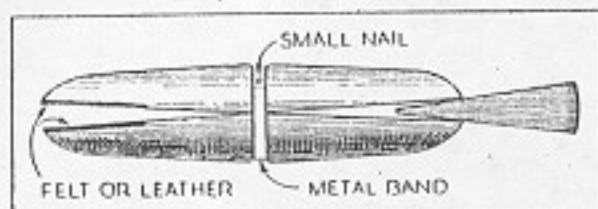


POPULAR SCIENCE MONTHLY December, 1935 HAND VISE FOR HOLDING SMALL PARTS

SMALL objects such as jewelry or parts for models may be held conveniently in a homemade clamp or hand vise like that shown in the accompanying illustrations. This useful accessory can be turned on a lathe or shaped by hand. A good size is $1\frac{1}{8}$ in. in diameter and 6 in. long, but this may be varied as desired. The band around the middle may be tin, brass, or any thin metal $\frac{1}{8}$ in. wide and long enough to go around the clamp. The wedge is made the same general shape as the end of the clamp, but the size and thickness



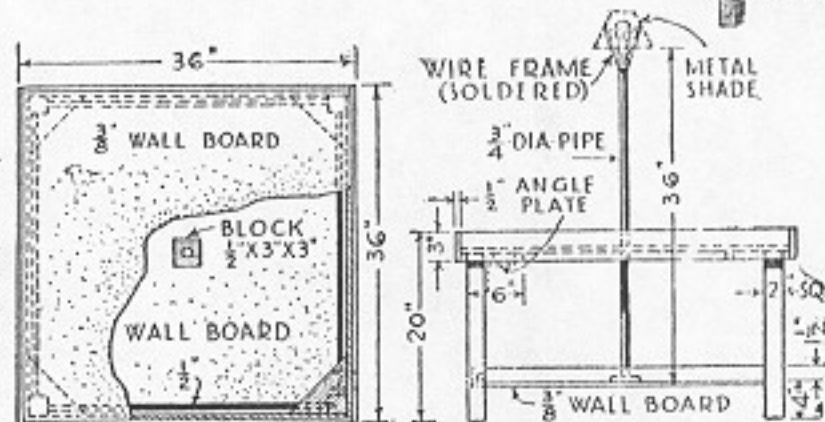
will depend on the amount cut out. It is, of course, advisable to line one end of the clamp with felt or leather to protect the piece being worked upon from any danger of becoming scratched.—PAUL G. LACKEY.



Popular Science Monthly SEPTEMBER, 1933 PLAYTABLE KEEPS TOYS OFF THE FLOOR

MOTHERS who are tired of the everlasting task of picking up toys scattered all over the house will welcome a playtable like that illustrated. There won't be so many toys to pick up and it will reduce, to some extent, the laundry work on children's play clothes.

The table is of the simplest construction, and only four sizes of wood will be needed. The light, which is one that cannot be knocked over and is therefore entirely safe, makes the table useful on dark days and in the evening. The wire may have a small rubber hose slipped over it as an additional safety precaution. The rim around both the table top and the storage shelf keeps the toys from sliding or rolling off.—DONALD W. CLARK.



This playtable has several advantages. There is a rim to keep the toys from sliding or rolling off; a large shelf with a similar rim provides ample storage room; and the light cannot be accidentally upset

PROPELLERS WHIRL UP TO KITE

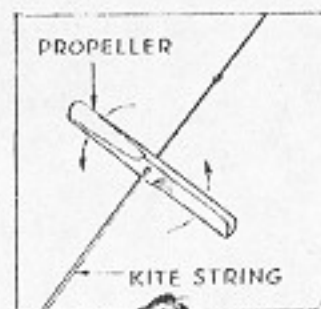
KITE propellers of balsa wood or any other very light wood will greatly increase the interest of kite flying. These propellers may be of any convenient size. A propeller 6 in. long with the blade approximately $\frac{3}{4}$ in. wide has been found generally satisfactory.

A hole is drilled in the center of the propeller for the kite string. When the kite is in the air, the end of the string can be passed through the hole, and the wind will twirl the propeller and carry it rapidly up the string to the kite, where it will continue to rotate as long as the kite is in the air. A series of propellers may be sent up to the kite until their weight becomes too great.

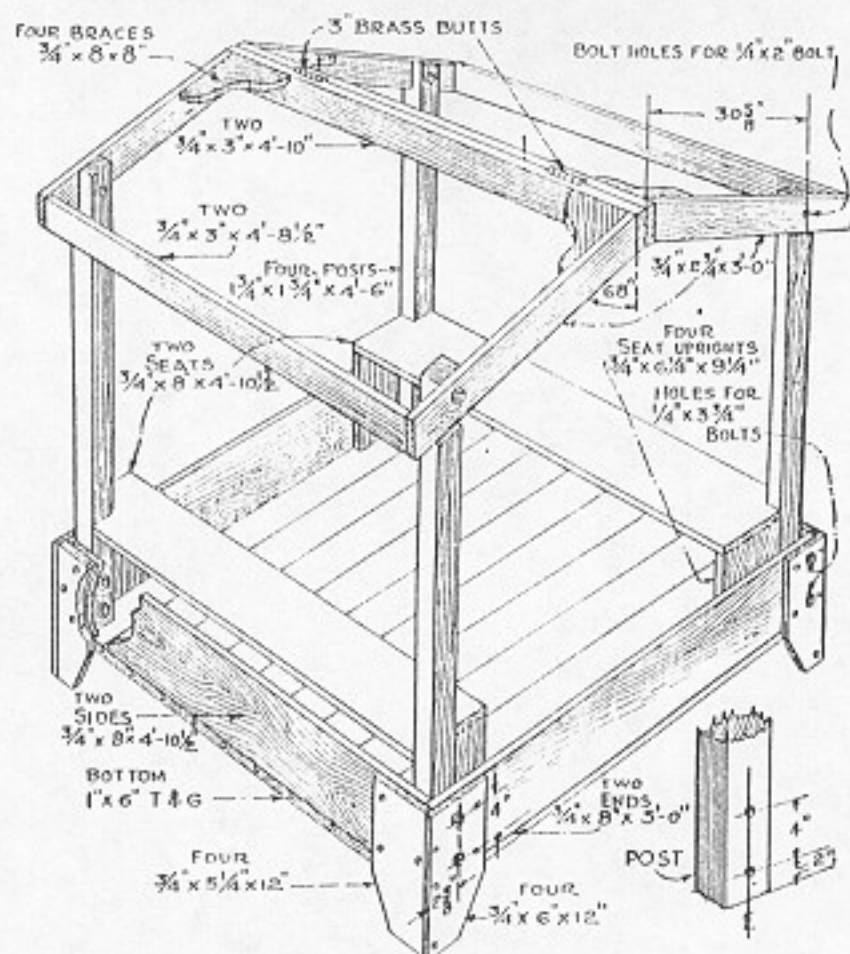
Another way of using them is to place knots in the kite string at, say, 100-ft. intervals. Use one propeller between each pair of knots and place a small glass bead between each propeller and the knot ahead of it. As the kite string is unwound, each propeller will twirl and follow up to the next knot, where the bead will act as a thrust bearing. The kite string will have a unique and attractive appearance with propellers whirling at spaced intervals along it, especially if the propellers are brightly colored with either enamel or lacquer.—WILLIAM E. GALBREATH.

POPULAR SCIENCE MONTHLY

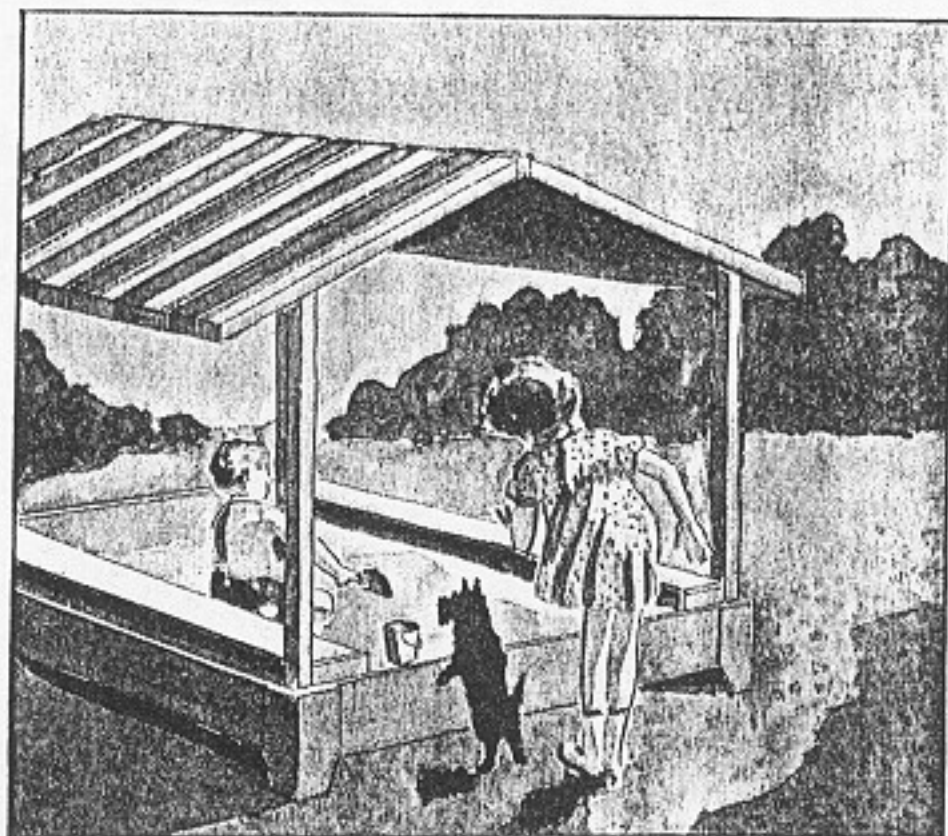
August, 1933



Sending up kite propellers to twirl on string



The upper framework of this easy-to-make sand box is put together with bolts so that the parts may be dismantled and laid in the bottom of the box for compact storage during winter.



Youngsters Will
Enjoy This

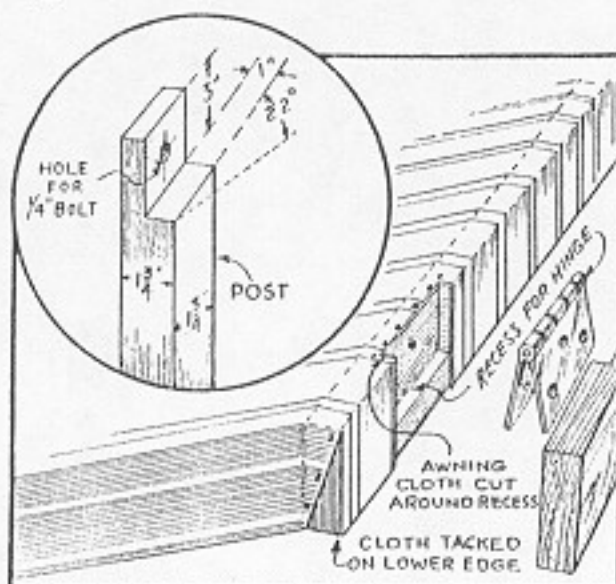
BACKYARD SAND BOX

THE HOME CRAFTSMAN July/August, 1937

EVERY youngster likes to play in a sand pile but without some sort of sand box he cannot always have his wish granted. The sand box presented here is the real solution to the problem because it brings a miniature seashore into the backyard but prevents the sand from being scattered about.

Special features make this sand box above the average. Short legs keep the box off the grass, a canopy overhead offers protection from the sun, and the construction is such that the posts and canopy framework may be taken apart and laid in the bottom of the box for compact storage of the entire unit during winter.

The construction is started by cutting the two ends and side pieces of the box. Butt joints with 2" screws will hold this frame together. The bottom is made of 1" x 6" tongue and groove stock fastened to the bottom with 8d nails or 1 1/2" flat head screws. It is advisable to use screws in place of nails to withstand the weight of



sand and the youngsters playing in it.

Eight pieces that form the legs are cut to shape and held to the box with 1 1/4" No. 10 flat head screws. The holes that are to take the 1/4" bolts, which will be used to fasten the posts to the box, are located as shown in the drawing. These bolts will also reinforce the legs to the box.

Posts are made of 1 3/4" square

stock, 4'-6" long. The top end of each post is notched to form a shoulder on which the roof rests. It is necessary to cut this notch 1" wide, whereas the pieces of stock used for the roof are only 3/4"; otherwise, the roof frame which is 1/2" shorter than the inside length of the box could not be fitted over the four posts. The roof frame is made short in order that it may be folded and placed in the

box for compact storage. A 5/16" hole is bored for the 1/4" bolts, as shown in the detail. The lower end of each post has two 5/16" holes to take the 1/4" bolts that hold it in place. These holes are bored in the center, 2" and 6" respectively from the lower end.

The frame for the roof is made up in two sections, hinged at the center joint. The sides of these frames are cut as shown. The angle of the ends is 68 degrees and may be cut on the circular saw. Pieces that form the top or ridge of the frames are 3/4" stock, 3" wide and 4'-10" long and are fastened to the sides with 1 1/2" No. 8 flat head screws. The cross-pieces forming the lower edge of the frames are made of the same stock, 4'-8 1/2" long, and are fastened inside the side pieces. The lower edge of these pieces may be beveled at an angle of 22 degrees in order to conform with the lower edge of the side pieces. Beveling may be done on a jointer or circular saw before assembly, or it may be done with a plane after the frame is put together. A 5/16" hole is bored in each of the side pieces to take the bolt that fastens

the frame to the posts. The corner braces are cut to shape from the 6" x 12" pieces and are fastened to the frame with 1½" No. 8 wood screws. The recesses for the 3" hinges are cut in each frame.

While cutting the benches of $\frac{3}{4}$ " stock cut the $1\frac{3}{4}$ " x $1\frac{3}{4}$ " notch

which is made in each corner of the seat to fit around the post. The seat is fastened to the uprights with screws.

The color of paint used may vary to suit the individual craftsman but a suggestion is to paint all the seats red and all other parts green.

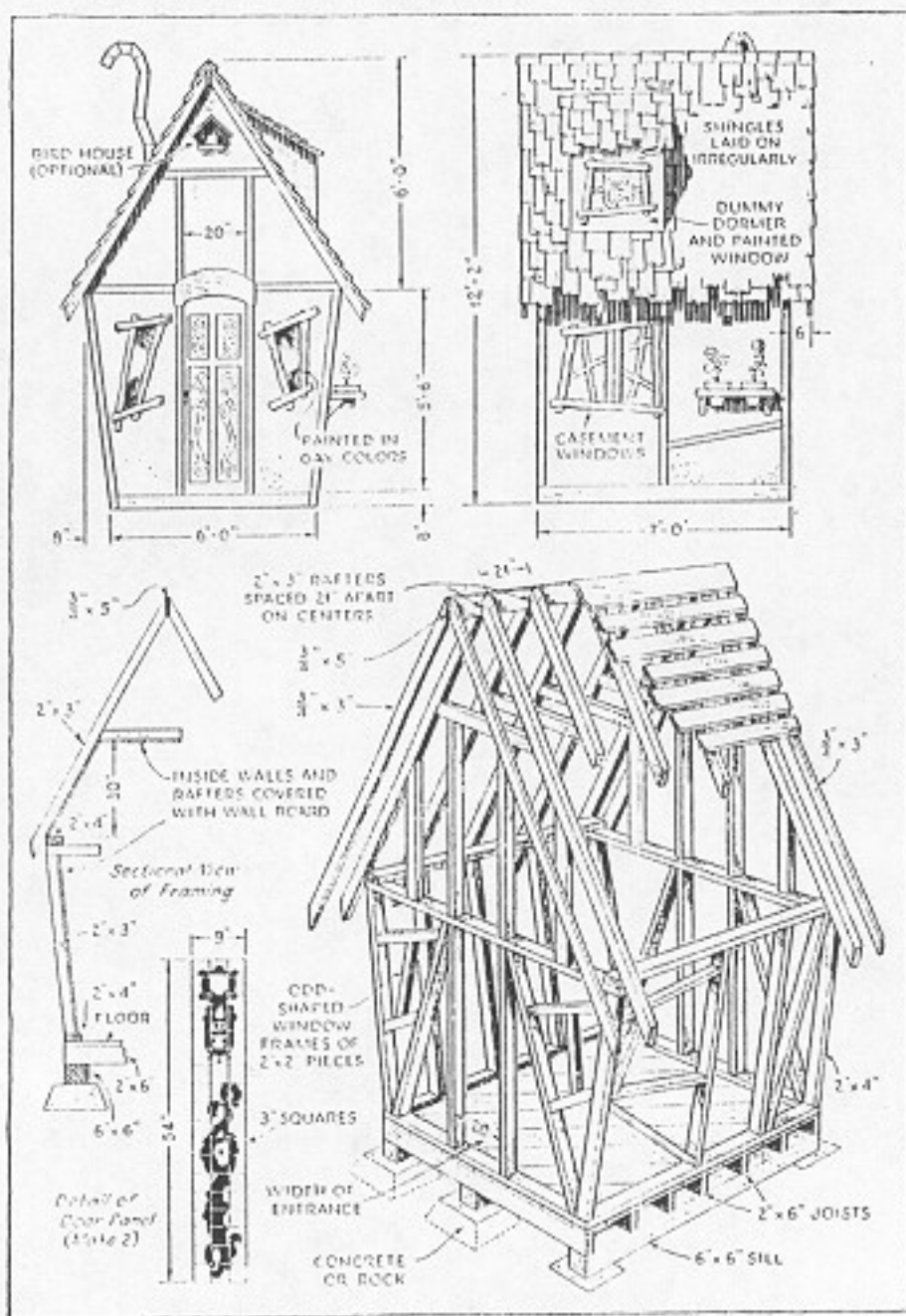
Awning cloth is stretched over the

frame and secured with small copper tacks. It will be necessary to cut out the cloth around the hinge recess after it has been fastened to the frame. The hinges are put in place after the roof has been covered.

A Fairy-Tale Cottage

TO ORNAMENT YOUR GARDEN

POPULAR SCIENCE MONTHLY June, 1935



Used either as a child's playhouse or as a tool house, this building adds a quaint touch to any garden. The construction is shown at left

ORIGINALITY and imagination are embodied in this little fairy-tale cottage, which can be constructed in any garden at relatively small cost. Besides serving as an ornament, it may be put to practical use either as a play-house for children or as a tool house.

The original building was erected in Laguna Beach, Calif., where it was found sufficient to cover the framework with wall board. The seams were concealed with battens and the whole protected against moisture with several coats of paint. Boards, wood siding, or shingles would, of course, be more substantial.

Wall board is fastened on the inside of the walls and over the rafters. There should be a vent in the ceiling and in one gable. The space under the peak of the roof may be used for a bird house, if desired, with an entrance in the front gable.

A bright color scheme such as red, black, and bronze, or light and dark green with orange trimmings is most effective. Plant shrubs of the more unusual varieties around the house and, if possible, lay a winding flagstone walk.—H. SIBLEY.

POPULAR SCIENCE MONTHLY

January, 1933

HOLDING SMALL OBJECTS WHILE PAINT DRIES

WHEN drying small parts that have been varnished, shellacked, or painted, it is always hard to find a convenient place to set them so that they will not be permanently marked where they come in contact with the surface on which they rest.



Thumb tacks pushed through cardboard support small, freshly painted objects while drying.

To accomplish this, take a sheet of cardboard and through it stick a number of large thumb tacks in such a way that each of the painted objects can be rested lightly on three or four sharp points as shown in the illustration below. The points will leave no trace of their contact, and the air can circulate all around to facilitate the drying.—FRANK W. BENTLEY, JR.

HUNGER IN AMERICA

By Kurt Saxon

Last week PBS aired a weird program entitled "Hunger In America". It was weird because not one of the families shown as examples of hungry Americans were destitute. They all had living quarters, some had jobs and even land and each had the money or food stamps which should have provided them with a more than adequate diet.

The commentator was in full sympathy with those hungry people and lamented the fact that nothing more was done. I watched this bizarre exhibition of the helplessness of the otherwise able and heard the pity of the "there but for the grace of God go I crowd". I harked back to tales of other starvelings.

In 1845 the Irish potato blight raged and hundreds of thousands starved in the resulting famine. Yet, it was found that on farms where whole families had starved, the barns held corn, oats, rye and barley in the cattle feed bins.

In France and Belgium, millions were starving after WW I. America sent boatload after boatload of corn and the people were insulted at being sent food for horses and cattle.

Stalin deliberately starved millions of kulaks in the '30's. When his henchmen moved in to cart off the bodies of the rebellious farmers, there too, was found plenty of grain in the feed bins. Of course, the livestock had been eaten but the livestock's food was not considered fit for humans to eat.

That people would starve to death before eating corn is a misleading concept. Had the corn been ground and made into cornmeal mush those people would have survived. But they simply didn't relate to corn as food.

Of course, you've heard of the African Bushmen and the Australian Aborigines.

They can thrive where Europeans wouldn't see any food at all. But that is an extreme. The point is that people tend to see as food, only that which they are accustomed to eating.

The people on the program were accustomed only to prepared foods bought at the supermarket. One couple with four kids got \$390.00 a month in food stamps. The man was an auto mechanic who had quit work since he couldn't afford his wife's medical expenses and his loafing would entitle her to Medicare.

They had four children and lamented the fact that the \$390.00 in food stamps were all used up before the next month's dole. Oh, you know food prices today and how \$390.00 for a family of six doesn't go far. I don't suppose they spent every bit of it on TV dinners and in the deli section. Nonetheless, to a Survivalist family, \$390.00 would buy about four months' food for six; maybe more.

That reminds me of 1976 when I was a bum in San Francisco. I was living in a \$10.00 a week sleeping room and worked off and on as a fry cook and a freelance house-painter. For a no-sweat \$5.00 a week I was selling my blood and so contracted infectious hepatitis.

That's a very debilitating illness and its effects last about a month when not fatal. Anyway, I was barely able to get around and I couldn't work. I wasn't hospitalized since the illness wasn't communicable except through dirty needles, as in my case. But the hospital gave me some pills and arranged for me to get welfare.

To a single person with what I had, short term, the welfare people paid my rent and gave me a \$6.00 food voucher each week. With that food voucher I bought sugar, yeast, cheap fruit, margarine, pinto beans, bacon ends, corn meal, raisins, rice, canned milk and odds and ends. Quite a box of food for only \$6.00, even then.

I had a hot-plate I'd bought earlier in a

Salvation Army store for a dollar and odd pots and pans. One of my favorite dishes was rice and raisins and canned milk. Delicious, nutritious and cheap. Of course, \$6.00 wouldn't go that far now, but I'd do just as well on its equivalent today.

Notice, I didn't buy any prepared food, nothing in cans or ready to eat. The sugar, yeast and fruit was for booze I started in several one gallon wine bottles. Five days later and from then on I had all the booze I wanted and just as good as store-bought.

Another group interviewed on the program was a farm worker who had fathered fifteen children. He had a wife and eight children living with him. His wife was preparing boiled baloney and rice. They were hungry.

Yet, he was shown plowing around onions and some kind of greens. The children, strapping, albeit ill-favored, were shown in the yard. Behind them was a great stand of weeds. Now, why didn't the man use from the field he was cultivating, as was his right? Why weren't his children cultivating a garden?

These people didn't want to be hungry. Obviously, he spent his food budget on food which was cheap enough but too expensive to supply ten people. But again, why didn't the man have a garden for all those children to work?

Naturally, the narrator never mentioned the fact that too many children born to incompetents was a major contributing factor to hunger; and most other social and economic ills.

The farm worker and his brood were in Alabama but I've seen the same thing in Appalachian coal country on other programs. Run-down shacks with whole families of unemployed adults and their many children loafing on the porch. No gardens! They were hungry too, as the narrator of that program gloated in an attempt to make the viewers feel guilty.

Another family in "Hunger In

America" was Mexican migrant farm labor. The father was heavy and the others were sturdy-looking. Of course, they wouldn't have much choice in food from the fields, since stuffing oneself with cucumbers for a week would hardly make a balanced diet.

I suppose they also had inadequate living quarters and kitchen facilities. Maybe they didn't even have a super-market close by. Even so, they could have bought masa in bulk for making tortillas, and pinto beans by the 25 pound sack, and with gleanings could have eaten as well as if they were earning they equivalent in Mexico. But as it was, they didn't speak English, migrant labor was their lifestyle and they had chosen, directly or indirectly, to live on a day-to-day basis. They simply lacked the adaptability to make that lifestyle as efficient as it could have been.

Another family on the program owned a dairy farm. They weren't doing very well at it so they were hungry. But with even a small dairy they had milk, and from it, butter, buttermilk, cheese and yogurt. There were no chickens in evidence, although several dozen could have lived off spilled feed and undigested grain in the cow lot. Why weren't they supplied with chickens and eggs? Where was their garden?

In all these cases there was no reason for hunger. But each family was too ignorant of food, as such, to prepare nourishing meals from cheaper, more basic ingredients. Instead, they unrealistically paid others to process their foods. Consequently, they could afford only about a third of the food they would have had, had they processed it themselves.

A while back I read a Reader's Digest article on hunger in America. Their argument was that there was no reason for hunger here, as I've pointed out. But their idea was that those who weren't eating as much as they needed was because they didn't know where to apply for more aid!

What amazed me was that neither the narrator of the program nor the writer of the

article considered educating such people in simple home economics. Knowing how to cook and knowing what foods give energy would have enabled them to shop for foods which would have been cheaper but more filling and more nutritious.

Several years ago this idea was brought home to me while watching a local San Francisco news story on malnutrition among the aged there. Featured was an old man on a fixed income who ran out of food about a week before his next Social Security check was due.

He was shown cooking his supper. His main course was Canadian bacon. In case you aren't familiar with it, it was in a roll rather than slices. It cost three times as much as regular bacon. He was buying gourmet food on his income from Social Security!

That's the problem with the families on the program. They were buying, in effect, gourmet food on welfare budgets. No wonder they were underfed and malnourished.

Most of us have seen people paying with food stamps for TV dinners, steaks and other highly processed foods. They just don't know how to buy food. All they know about food is what they see on TV. If they can't afford it; if they spend all they have on what intelligent wage-earners can't afford, no wonder they're hungry!

But the bleeding hearts would only have us give them more money. For them to eat like they must if they can't economize like the rest of us, we might as well give them all food vouchers to take all their meals at fancy French restaurants. It won't work. As things get worse, they'll starve.

More rational sympathizers might suggest TV programs (hosted by rock-n-roll stars, Jim and Tammy Bakker and sports heroes, to keep their attention) demonstrating the buying and preparation of inexpensive and nutritious foods. Of course this would have to be on PBS, which they never watch. Otherwise, the makers of

Captain Stupid's Sugared Breakfast Crunchies would protest, along with all the other advertisers of the equally debilitating carcinogens and brain-rotting delectables morons have been sold as staples for years.

The point is, millions of Americans are so ignorant about food that without the media they wouldn't know what to eat at all. And with the inevitable rise in food prices and cuts in welfare, those millions are going to starve.

But that's not the half of it. Next time you go to the supermarket look at the foolish people with their carts piled to overflowing with expensively packaged foods hardly fit for human consumption. One doesn't have to be a health nut to shudder at what most of that does to the body and brain. Most people who make good livings don't know any more about staple foods and their preparation than do the welfare morons.

This is because, in our prosperous culture, food is usually taken for granted. Urbanites really had no time, and seldom the facilities for preparing foods from basic staples. Also not too long ago, food's cheapness, even processed and packaged, make it impractical for the homemaker to process staples.

But now, with the rising costs of food, energy, packaging, etc., food has become a major budget outlay. Therefore, it is becoming more practical to buy in bulk and process one's own food. But since Granny baked bread weekly, made sausages in the fall, had a kitchen garden even in the city, and distrusted canned foods, people have suffered a kind of cultural amnesia concerning food.

So people are hungry in the midst of plenty. And fewer people are left to pass on the basic techniques to fewer people who care to learn them.

I was fortunate in having nothing but peasant ancestors who were too poor to hire commercial food processors to prepare their

food. In my misspent youth I never hungered because I knew food and how to prepare it.

This ability really came in handy when I had the accident which damaged my hand and left me nearly blind for months. In 1970 I was getting \$87.00 per month County Welfare. My little apartment cost \$50.00, leaving me only \$37.00 a month for food and incidentals. I spent less than \$5.00 a week on food and ate better and tastier foods than I had when I could afford anything I wanted.

Most of the processes I knew and developed then are in SURVIVOR Volume I. They will guarantee anyone an abundance of nutritious food for about a quarter of today's food prices. This book is the most important in my whole line and could save you enough to afford all my books and tapes with a couple of month's savings.

Many of the processes are shown in my tape, "The Poor Man's James Bond Strikes Again". The information was given there to illustrate the fact that the embattled Survivalist can hold out almost forever with the right kind of food supplies. Without such foods, any survival program may fail.

Unfortunately, less than half my subscribers have bought Survivor Vol I. Some take pride in having stocked up on "survival foods", a snare and a delusion which will doom many. This is because such foods are simply stored. They don't increase in food value as do grains used for sprouting. They need no processing except for adding water.

They also cost up to ten times what I recommend and are not nearly so good tasting or nutritious. The worst thing about them is that the Survivalist doesn't learn the skills insuring survival on a long-term basis. Without such knowledge and skills the "Survivalist" will be useless to his neighbors and so may be driven from the community when his supplies run out or are looted.

On the other hand, unprocessed foods are the last items a looter would want or

would even recognize as food. Not nearly so portable and lootable as the neatly packaged and labeled meals like Mountain House Freeze-Dried Foods, for instance.

Another class of Survivalists are those fixated on weaponry and personal defense; and maybe offense. That type saddens me as they are incomplete and also contributes to the negative side of Survivalism.

The media image of the Survivalist is a camouflage-clothed dingbat living in a hole in the ground and waving guns at everybody. I made up the term and that's not my definition. But all too many of my readers seem to try to live up to it.

But the arms-crazy type won't make it. Banditry is self-defeating. Say you take food by force from one, two, maybe three families. Logic and the law of averages should show you that you're only working your way to a real Survivalist who will destroy you.

Bandits are just as dependent as any other losers. You must be self-sufficient in many areas in order to survive the coming collapse. And self-sufficiency in food is the most basic and most important survival skill.

Surprisingly, self-sufficiency in food is the simplest and also the most profitable survival skill. As shown, it will take care of you now and save over half your food bill. When it becomes an absolute necessity, you will be among the most valued members of your community.

So sure, there's hunger in America. There will be more and only those who have become independent of the food conglomerates will be prepared for a future which will doom millions.

Popular Mechanics June, 1902

Europe has a population of 357,379,000 souls; Asia, 825,954,000; Africa, 163,953,000; America, 121,713,000; Australia, 3,230,000; Oceanic Islands, 7,420,000; polar regions, 80,400; total, 1,479,729,400. The same continents and islands have an area of 52,821,684 square miles.

World population in 1996;
5,800,000,000

Spoon-Fed PLANTS

Reveal Secrets of Growth

Fruits, Vegetables, and Grains Thrive and Ripen Without Soil In Tests To Increase Production

By ANDREW R. BOONE

POPULAR SCIENCE MONTHLY SEPTEMBER, 1936



This French prune tree has been growing for four years in a garbage can filled with water containing a nutrient solution. It is one of a group being cultivated under controlled conditions for a study to check fruit disease

PICTURE nodding heads of wheat ripening under blue artificial suns, their roots growing not in soil, but in water; or tomatoes, producing 700,000 pounds an acre, growing in excelsior and water; or orchard and forest trees thriving without benefit of soil.

In the laboratories and greenhouses at the University of California I saw, recently, a dozen kinds of plants approaching maturity, in conditions duplicating those of nature, from the north pole to the equator, with a few synthetic conditions added for good measure.

Trees, which already have borne fruit, were growing in garbage cans, their nourishment taken from water which is "fed" once each week from a bottle. Sequoias, held upright by corks, were reaching their branches toward the sky, their roots spread out in shallow pans. Sunflowers, tomatoes, potatoes, carrots, barley, and wheat likewise have been grown on these "water farms," and produced lush yields far beyond the dreams of dirt farmers.

Some are exposed to natural sunlight and grown at ordinary temperatures; others reach maturity under the glare of synthetic suns, their roots held at one temperature, their heads at another. One plant is fed one diet, its neighbor thrives on quite another. From these controlled lights, diets, and temperatures, some surprising results have been attained.

Take wheat. In the miniature wheat fields, housed within glass show cases in two aluminum-walled basement laboratories, Prof. A. R. Davis needs only to turn a switch, and breezes fan the growing grain; he turns a second knob, and the temperature rises to 110 degrees or falls to freezing; he adjusts the air intake, and the plants are subjected to the aridity of a desert or humid ocean breezes.

As for sunlight, he can produce not one but a dozen suns, ranging from blue through natural sunlight to bright red. These, shining from brilliant lamps ranged around the show cases, may "rise" singly at different times, or all together, and cast their glare on the grain until the scientist decides that the green blades have had enough for the day. Ordinarily, the day commences for these incubator

plants at five o'clock in the afternoon, and the suns "set" at nine in the morning.

These phenomena are not natural, Dr. Davis explained as I observed the blue suns beaming on several trays of sturdy wheat. All are synthetic products of scientific ingenuity to catch nature off her guard and wrest from her the secrets of plant growth. What I saw was literally a scientific third degree, intended to elicit the secrets of life processes in the plant world.

"Such strong-arm methods," Dr. Davis commented, "are essential if man is ever to understand and control his fundamental food source, the plant kingdom."

Nature never reveals these little-known facts. Soils vary from place to place and from season to season; the climate of one year is never exactly the same as it was the year before or as it will be the next; intensity of the sunlight changes; the humidity of the air rises and falls, and temperature is influenced by many factors.

So, here in the laboratory, the scientist substitutes for uncertain nature known temperatures, humidity, and light. He also supplies to the roots nutrient solutions containing measured

quantities of liquid foods.

To go back to the real beginning of these experiments, the descendants of a single grain of "little club" wheat, a native of California, were established as a pure line at the University of California College of Agriculture. After they had proved themselves constant, selected grains were brought to the laboratory and planted.

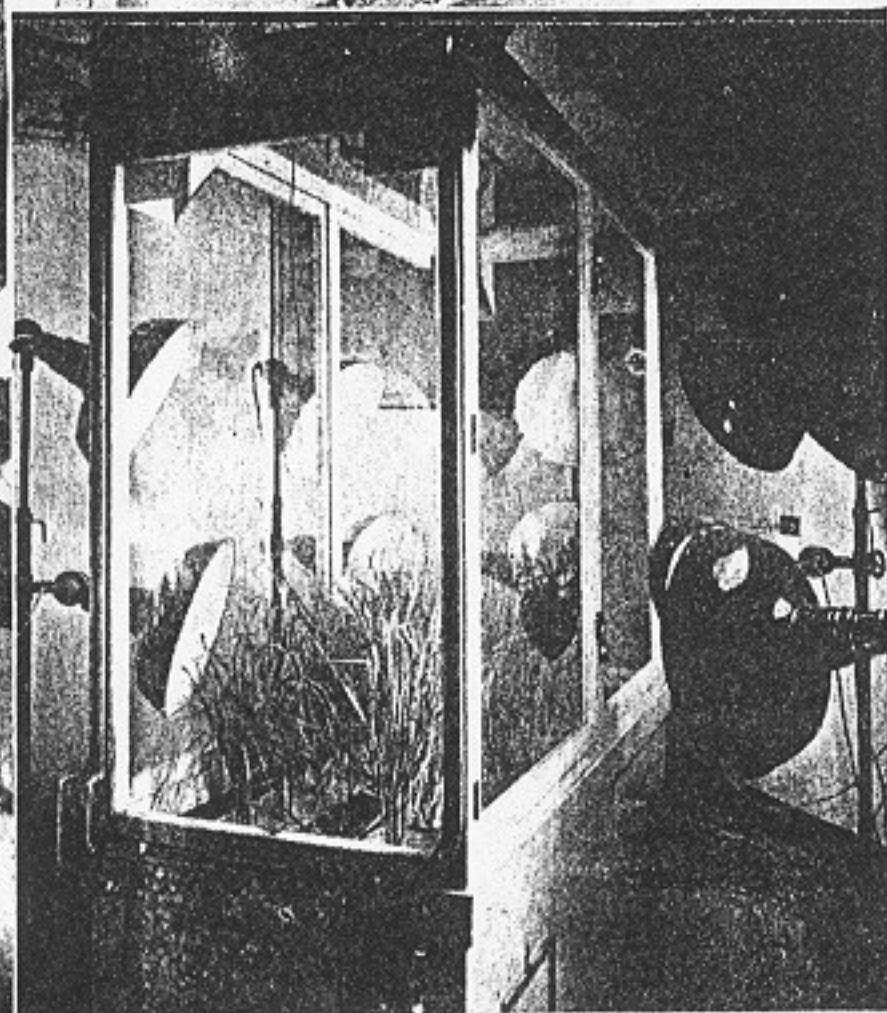
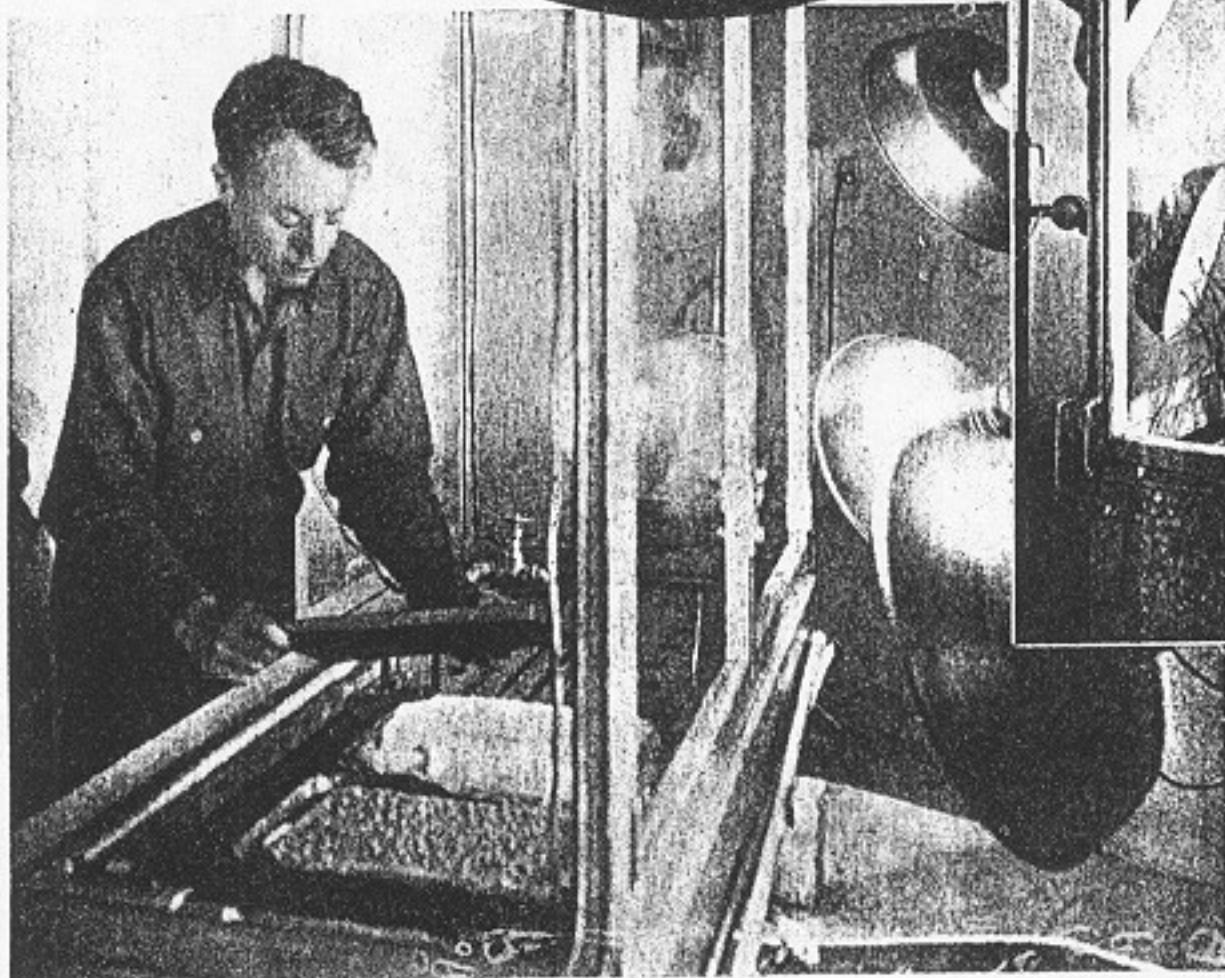
Here, the planting bears little resemblance to the common agricultural method. The grains first are soaked overnight in cool water to loosen their skins, then placed on a metal screen. A second moistened screen serves as a cover, thus providing a saturated atmosphere both above and below.

For three days, the germination pan is left in a darkened cabinet. During this time the roots will have felt their way down into the water, and the tops begun to sprout. As soon as the tops appear, the synthetic sunlight is turned on to begin the manufacture of green coloring matter for the

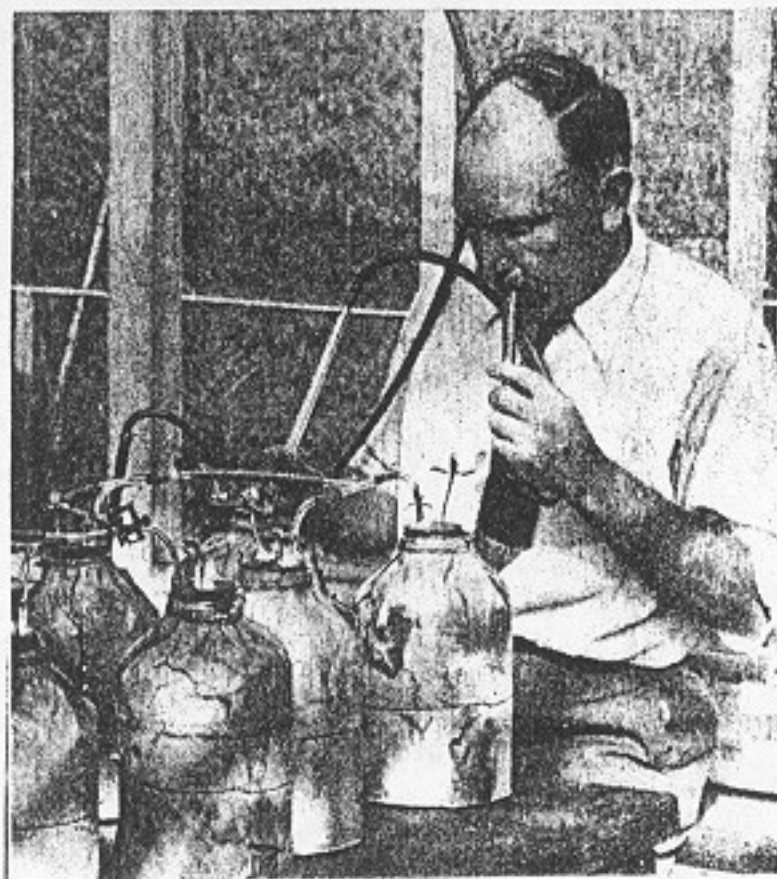
Growing without soil, these tomato plants produced the equivalent of 350 tons of tomatoes to the acre. They are bedded in excelsior and their roots extend downward through a wire screen into a solution of chemical foods



A chemist taking a sample of the solution from around the roots of a tree in the experimental "orchard." Chemicals are added, when needed, to keep the acid-alkali balance



Wheat ripening in a temperature-controlled glass case under the glare of artificial suns. No soil is used in this experiment, the stalks growing out of pools of water like pond lilies. At the left, wheat grains are being "planted" in a moisture-saturated pan for cultivation under red "sunlight"



Week-old sunflower plants serving as guinea pigs in a test to show the relation between plant diet and disease. The bottles contain liquid food, and oxygen is supplied by means of the rubber and glass tubing

stalks or leaves. This is essential, for through the green leaves, the tiny plants manufacture their own food.

When the wheat attains an average height of two and a half inches, Dr. Davis carefully selects several score plants, all within a quarter inch of the same height, for transplanting. Since the principal function of soil has been found to be supporting plants in an upright position, these are placed in ordinary bottle corks fitted into a frame, each cork supporting the stalk of one plant. Room for expansion is provided by making the holes extra large and packing cotton around the stalks.

FROM this point on, in addition to controlling nutrition and temperature of the roots, Dr. Davis also controls every factor influencing the tops of the plants. He may provide Alpine conditions by creating low temperature and high humidity at one time, only to switch to the desert by combining high temperature and low humidity later, or bring in the tropics with high temperature and high humidity. Further, he may supply water to the roots at one temperature and air to the tops at another.

"In nature," he commented, "the roots are usually colder than the tops. We have seen striking changes in this wheat by lowering the root temperature to ten degrees, while holding the air at twenty degrees. Lowered root temperature, we have found, increases the sugar content of the root, and this tends to develop a hardier, sturdier plant."

As I stood looking at the large glass box, Dr. Davis demonstrated how he changes the weather at will. Into the case a stream of freshly washed air was being blown by fans, the moisture content kept constant automatically.

Stepping to the near-by controls, the scientist closed one valve and opened another. As I observed two instruments, I noticed that the temperature and humidity were rising. The dry, arctic cold was becoming a moist, tropical heat before my eyes.

"Likewise," the scientist explained, "the composition of the air may be changed by adding or subtracting oxygen, carbon dioxide, or any of the other gases the air ordinarily contains."

Then, as I looked on, red imitation sunlight suddenly bathed the cork-bedded wheat. "Why red?" I inquired.

"Sunlight, we know, is made up of rays of different wave lengths," Dr. Davis explained, "and their colors range from the long, red variety to the short violet. Science has known for a long time that plants need red and blue light, while yellow and green are less important. Until recently, little had been learned of the relative importance of red and blue and of the rôles they play in the growth and composition of plants."

"For that reason, we have provided our plants with red 'suns' and blue 'suns' and we have found striking differences in plants grown under the two conditions. For example, we have found that wheat deprived of blue light became long and spindling, like children with rickets. Plants deprived of red light become dwarfed in size and they are likely to die prematurely."

NOR were different colors alone responsible for some outstanding results. Tests have shown that a change in the length of day, with the "suns" shining at constant intensity, has a different effect than merely changing intensity. The wheat, for example, grew more rapidly in more intense light; but when it was exposed for longer times, the sunlight had an even greater effect! This is thought to account for the

fact that in the far north, where the sun is never very bright, but the days are long during the growing season, plant life springs up as if by magic.

An even more important discovery in this novel laboratory shows that plants which can stand a moderate temperature under one intensity of sunlight, can stand a much higher temperature in brighter light. Dr. Davis be-

lieves that this question of the relationship of light intensity and heat has an important bearing on the failure of lettuce, cabbage, and similar truck crops to form solid heads.

THIS wheat experiment likewise finds practical application in the greenhouses of the nation. Greenhouse owners often try to maintain a constant temperature throughout the year. But these results suggest that greenhouse temperatures should be lowered in winter, when the sun's intensity is low, since high temperatures without adequate sunlight affect plants much as a fever affects human beings, forcing the cell-building processes to proceed faster than food can be taken in.

While some of these experiments look toward purely scientific findings—the facts of plant physiology—others find ready application in higher production at lower costs and in combating disease.

For instance, Prof. W. C. Gehricke, also of the University of California, for several years sought a means of improving the quality of tomatoes at lower cost. Year after year, he set out young plants in a waterproof box two and one-half feet wide and ten feet long. He tried them in various kinds of materials, from sawdust to excelsior, and finally hit on a winning combination.

When I visited the laboratory, I saw the box filled with sturdy plants which had been set out two months earlier. They had attained a height of nearly two feet. The stalks were supported by a layer of excelsior two and one-half inches thick, resting on a screen of chicken wire. Their roots extended into the water, which contained a balanced nutrient solution of calcium nitrate, potassium nitrate, magnesium sulphate, potassium phosphate, and ferric tartrate, the elements necessary to plant growth.

Beyond "feeding" the plants one pint of the solution twice during their growing season and keeping the twenty-five gallons of water at a temperature of about seventy-two degrees, with room temperature between eighty-five and ninety degrees, the scientist gave them little attention. On the basis of last year's yield, 365 pounds from the small tank, tomatoes so grown are expected to produce the astounding total of 350 tons an acre. Now, for the first time, at Los Angeles and Santa Cruz, Calif., growers are trying out the "water culture" methods on a large scale.

BY A similar method, Dr. Gehricke has produced astoundingly large quantities of potatoes, radishes, and carrots in his beds of excelsior.

Nor are these all. As I walked through the near-by greenhouses, I saw sunflowers growing in bottles, fed by carefully balanced nutrient solutions and aerated through rubber lines leading into the water solutions; sequoias, taken from cuttings and now two years old, growing in corks, their roots floating in water contained in shallow pans; barley, in various stages of hardness.

The barley, I learned, has yielded some odd facts. From several plants nitrate was withheld. With almost human intelligence, the tender young roots shot out almost overnight to surprisingly great lengths, actually searching for the missing element. Others, denied

iron, died; yet, when only one drop of iron was added to the water for one night, plants of the same age absorbed enough to carry them through to maturity without turning yellow. Others, lacking sulphate and magnesium, grew until they started to form heads; then they, too, died.

Tomatoes, sunflowers, and squash were serving as plant guinea pigs in experiments to find a cure for "little leaf," a disease resulting from deficiency of zinc, which causes leaves, particularly at the end of apricot-tree branches, to become yellow and sickly. Some were growing with lead added to their diets, others without. By changing diets, the scientists are trying to produce "little leaf" in these garden plants. Then they will know the cause of the disease, and how to combat it.

SEVERAL years ago, a disease known as chlorosis attacked fruit trees in a central California valley. Caused by an excess of lime in the soil, this disease interfered with the iron metabolism and caused leaves to turn yellow, thereby limiting their ability to take food from the air. Investigation revealed that the disease was attacking trees all the way from Kansas to the Pacific Coast.

Into the hands of Dr. J. P. Bennett, professor of plant physiology, the problem fell. To solve it, he first recognized he must study the relationship between inorganic nutrition and chlorosis, and in order to control all fac-

tors he set out sixty French prune and pear trees, taken from nursery stock, in ordinary garbage cans. Each can was painted inside with asphalt and marine varnish to prevent rust, and packed with moss, which kept down temperature during the summer. Into each was poured twenty-five gallons of water and a small quantity of a nutrient solution, containing calcium, magnesium, potassium, iron, sulphur, phosphorus, nitrogen, and manganese. In addition, oxygen was supplied to the roots by means of air bubbling up through the water.

From time to time, for four years, Dr. Bennett has changed the balance of the food fed to these trees, maintaining some in an acid diet, others in an alkaline solution, while still others were kept neutral. Once each week he takes a sample of the solution, tests it, and re-adjusts the diet, feeding the trees from a glass tube much as a new-born babe sometimes takes liquid from a medicine dropper. For two years, these water-raised trees have borne luscious fruit, many of them entirely free from disease.

"Whereas soil can only supply a few elements to a tree," Dr. Bennett told me, as we

examined the sturdy roots of one specimen, "here we can control all factors. For instance, if these trees were growing in a soil containing five percent of lime, that would mean that over the area required, the upper foot of soil alone would contain 200,000 pounds of lime. To neutralize such a soil, we would have to add an even greater amount of sulphuric acid. Here we can accomplish this around individual trees with only a spoonful of acid."

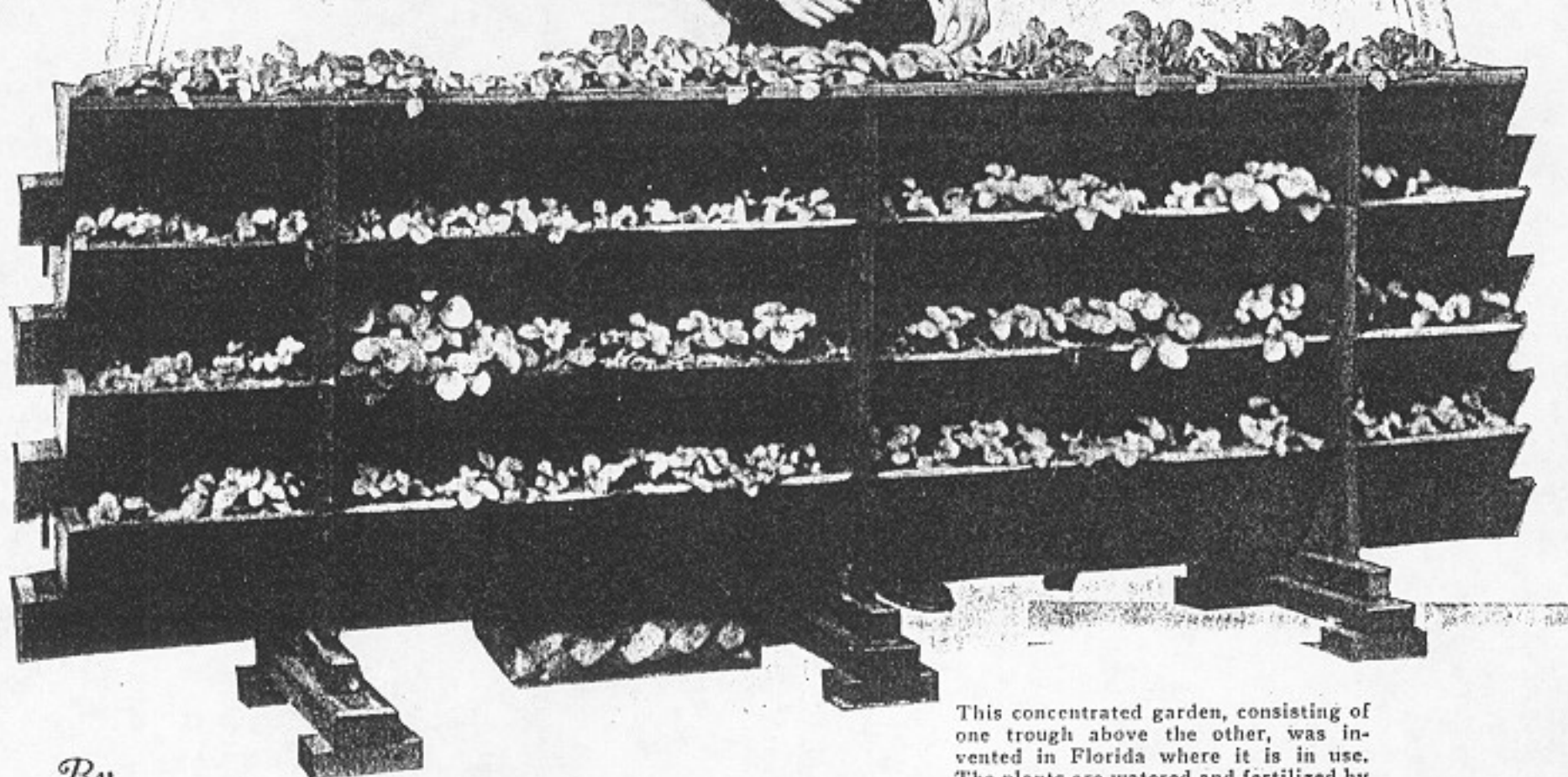
THESE remarkable experiments, while pointing a way to high productivity of fruits and vegetables, do not end here. Other experts in plant nutrition in the same laboratories are studying the effects of rare and little known elements on plant life, the food-supplying capacity of the soil, and the chemical composition of tissues within the plants themselves.

From these researches will come further and even more startling facts about the plants which furnish the food elements and without which neither beast nor man would be able to continue the fundamental life processes.

POPULAR SCIENCE MONTHLY

JULY, 1933

PLANT GROWTH SPEEDED IN Midget Gardens



By
Walter E. Burton

This concentrated garden, consisting of one trough above the other, was invented in Florida where it is in use. The plants are watered and fertilized by the same system. The arrangement insures the same amount of sunlight for each plant no matter what trough it's in

PLANT wizards and inventors have succeeded in reducing the size of gardens to a point where products formerly requiring an acre or two of space, can be raised in the back yard, or even indoors.

Several paths have been followed in reducing garden size without lowering the yield. At the moment, some of these have not been extended far beyond the experimental stage, but they give indications of great possibilities in the near future. Some need only general adoption to make them successful in a big way.

A Miami, Fla., inventor's idea of a vest-pocket garden takes the form of a series of patented wood troughs into which is built an irrigation and fertilizing system. Combining watering and fertilizing operations, without waste, makes his method particularly desirable.

The inventor, George Leon White, claims a 1,500 percent gain in space. In other words, he can raise on one acre crops normally requiring fifteen acres.

The sample trough system shown in the photographs can be expanded to cover as much ground as desired. The unit measures six feet long, one foot wide, and about three and one-half feet high. It contains 125 strawberry plants, thriving in twenty-four square feet of soil.

Each of the troughs has a false bottom that, along the intersection of the two sidepieces, helps form a narrow canal through which fertilizer-laden water can run. The water is poured into a compartment at one end of the top trough. Thence it runs to the other end of the trough, spills through an overflow tube into the second trough, continues to the opposite end, and into the next trough and so on until the plants in every trough are watered.

This continues until excess water finally flows into a container from which it can be dumped back into the top trough. In this way, none of the fertilizing material is lost. The water, as it flows along, comes into contact with the soil, which soaks it up and makes it available to the plant roots. The unit shown has been designed for use in sunrooms, on porches, and in yards.

The inventor, by making plant food directly available to the roots, has speeded up the growing process, in addition to gaining a saving in space. His trough units can be built to any height. A large installation can be watered by a windmill and tank arrangement.

Almost any plant, if not too big, can be grown in the troughs. This includes onions, radishes, strawberries, celery, beets, turnips, and some varieties of beans. The troughs can be arranged so that plants in both sides receive the same amount of sunlight.

The multiple-trough idea is a refinement of the old strawberry barrel or earthenware pot. If holes, an inch or so



In a compact box garden, like the one pictured here, vegetables are sprouted for winter use

in diameter, are bored at evenly-spaced points around the sides of a barrel, and the barrel filled with earth, strawberry plants, and various other garden products, can be grown successfully. The barrel can be watered by means of a funnel fitted into the top. A group of such barrels provides a comparatively large growing area on a limited amount of ground.

Experiments are being conducted with concrete barrels or cylinders several feet high. These cylinders have holes over the curved surfaces, through which plants grow. Water can be introduced at the top of the cylinders.

Widespread interest has been created by the wonders worked with concentrated plant food, of which certain plant pills are one form. Such food makes possible the ultimate in garden compression.

A California scientist has developed a chemical preparation which, when carried in solution in water, makes it possible to raise cabbages, celery, beans, and other garden products without the use of soil. The vegetables are grown in shallow troughs, sawdust and excelsior being used to hold them in position. So great is the concentration achieved that plants thrive when crowded so closely that they touch each other. A plant can be moved from one trough to another without disturbing its growth.

Other tricks of plant magic have been performed by Dr. J. T. Charleson, industrial chemist. Dr. Charleson has succeeded, by using a special preparation, in doubling fruit yield and trebling the production of flowers on a single plant. In addition to this two- or three-fold gain, his plant food, which is soluble in water, can be used in troughs or any other arrangement for holding growing plants.

Investigations made by universities and commercial establishments, Dr. Char-

leson points out, have indicated that there must be perfect coordination of

chemical elements to make a plant behave properly. In addition to the elements contained in ordinary fertilizers, there must be certain activators, or substances that act more as stimulants than as foods. Among the necessities for maximum yield of fruit or flower are phosphorus, potassium, nitrogen, boron, and manganese. They must be properly blended, or the plant will suffer.

Dr. Charleson's plant food takes a granulated form that can be dissolved in water, one quart making fifteen quarts of stock solution which is then diluted five to one before being applied with a sprinkling can. He perfected it primarily for use with water plants, but tests have shown that it is equally useful for vegetables, rose bushes, rock garden plants, and the like. A gallon of the stock solution is enough for seventy-five rose bushes, or 1,000 square feet of garden.

By means of the plant food, he has made water lilies and other plants bloom out of their usual season, and has produced flowers on aquatic plants that bloom so infrequently as to make the occasion a noteworthy event. In addition, the individual flowers generally are larger than normal. The inventor can, by varying the composition of his food, produce almost any desired effect, such as a plant that is all foliage and no flower. In fact, this is what ordinary fertilizers are inclined to do in many

cases, according to Dr. Charleson.

The U. S. Department of Agriculture recommends that an indoor sprout garden be maintained for providing vitamin-containing food during winter months when fresh garden vegetables are scarce. Nothing could be simpler or more compact than such a garden. The seeds, beans for example, are placed in a layer between several thicknesses of cheesecloth which is kept moist. Or the seeds can be spread on a plate and kept covered with damp cloth. In addition to beans, the various cereal grains, like corn and oats, can be sprouted. The products of a sprout garden are cooked as greens, there being little or no waste because roots and all are used.

The Department of Agriculture has done extensive research work in connection with the effect of daylight on growing plants. It has been found possible to change the flowering or fruiting period of many plants by prolonging or

decreasing the number of hours of light a plant receives each day. Thus, radishes have

Water hyacinths, right, are blossoming in November in an Ohio greenhouse as the result of treating them with plant food



In watering and fertilizing plants, grown in the trough garden shown on the opposite page, the mixture is poured into a tank, above, and drains to each trough in turn as is shown at the right



These tropical water lilies, blooming in a northern climate, show how plants respond when given prepared food as shown in photo

been prevented from going to seed when spring gives way to summer, and have been kept in an edible condition for over a year. These light-effect studies may lead to profitable means of growing out-of-season fruits and vegetables—which is but another form of concentrated or accelerated gardening.

ALTHOUGH not gardening in a strict sense, a method of injecting new life into old orchards, described by the late Luther Burbank, makes it possible to save years of time in growing things for money. Burbank pointed out several cases where a fruit grower purchased an old, run-down orchard for almost nothing, and then cleaned it up by pruning trees, removing underbrush, cultivating the ground around the trees, adding fertilizer, growing clover or some other beneficial crop around trees for eventual plowing under, and finally by grafting new stock on old trees.

A method of hastening the ripening of fruit has been used by large growers and wholesalers for some time, and is rapidly gaining in popularity. This is the treating of nearly-ripe fruit with ethylene gas. The process can

be adopted by the small-time gardener who desires early vegetables and fruit, or who wishes to dispose of a portion of his crop at maximum profit. Cost of equipment for this ripening process is low.

The art of fruit-ripening, now being revived, was developed by Chinese and Arabs centuries ago. Not many years back, growers of oranges and other products were using kerosene lamps and lanterns to speed the ripening of fruit. Later it was found that the active agent in kerosene fumes was ethylene, a hydrocarbon that is found in illuminating gas. Today, bottled ethylene is used.

Gassed fruit is, in many cases, superior to tree-ripened products. It often has a better color, is sweeter, better flavored, and it can be produced more quickly. Green fruit can be shipped great distances without bruising, and then ripened to meet market requirements at the point of consumption.

ETHYLENE gas is about as explosive as natural gas or acetylene. However, it is released into a room in such low concentration, one part to 1,000 of air, that there is little danger. The tank itself must be kept cool and not dropped, and no open fire can safely be placed near it. Usually the tank is taken

into the ripening room just long enough to release the required amount of gas. Then it is removed. A few minutes later, after the gas has diffused through the room, an open flame will not cause an explosion. There is no affect on breathing. The best fruit-ripening concentration of ethylene gas is one to 1,000, it takes a three percent concentration, or thirty times as much, to make an explosive mixture.

FRUITS and vegetables that have been ripened in large lots by the gas include tomatoes, bananas of all kinds, pineapples, celery, cantaloupes, limes, lemons, oranges, and grapefruit. Promising results have been obtained with pears, dates, jujubes, mangoes, peppers, alligator pears, pomegranates, apples, honeydew melons, papayas, plums, chayotes, custard apples, rhubarb, endive, chicory, and plantains.

Unfavorable results were obtained with asparagus, cauliflower, watermelons, and other products that have thick rinds and contain little hydrocarbonate reserves. Ethylene also has been suggested for fruits and vegetables from which tannins, chlorophyll, organic acids, and other bitter substances are to be removed. The gas can be used in converting starch in fruits into sugar.

POPULAR MECHANICS

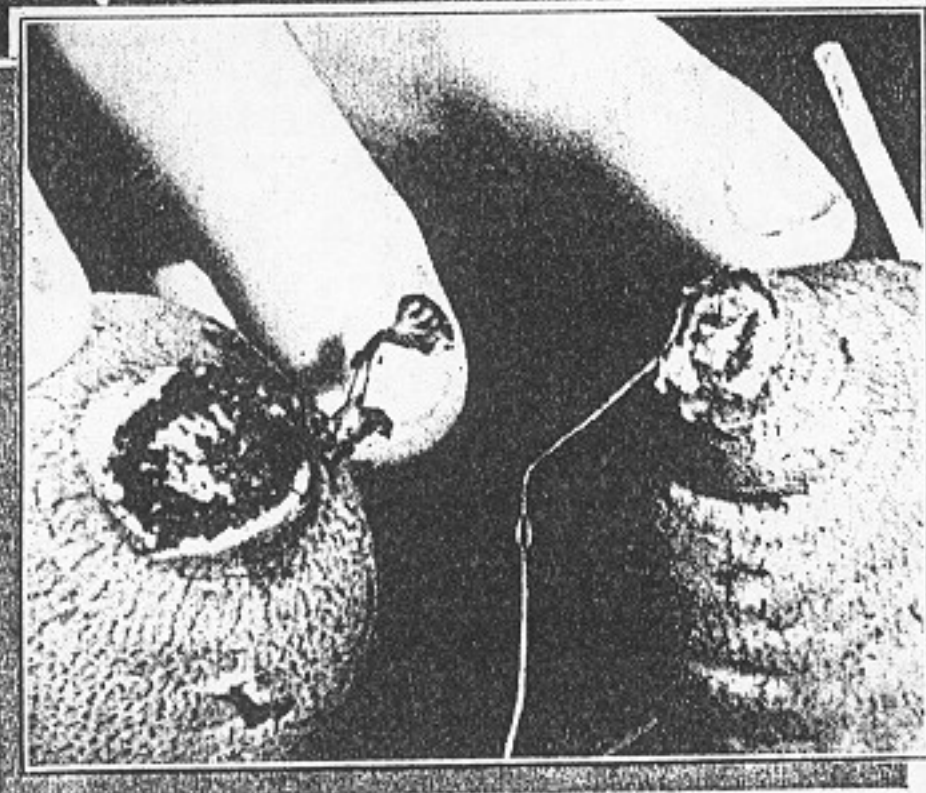
February, 1940

WONDER "FOOD" for PLANTS

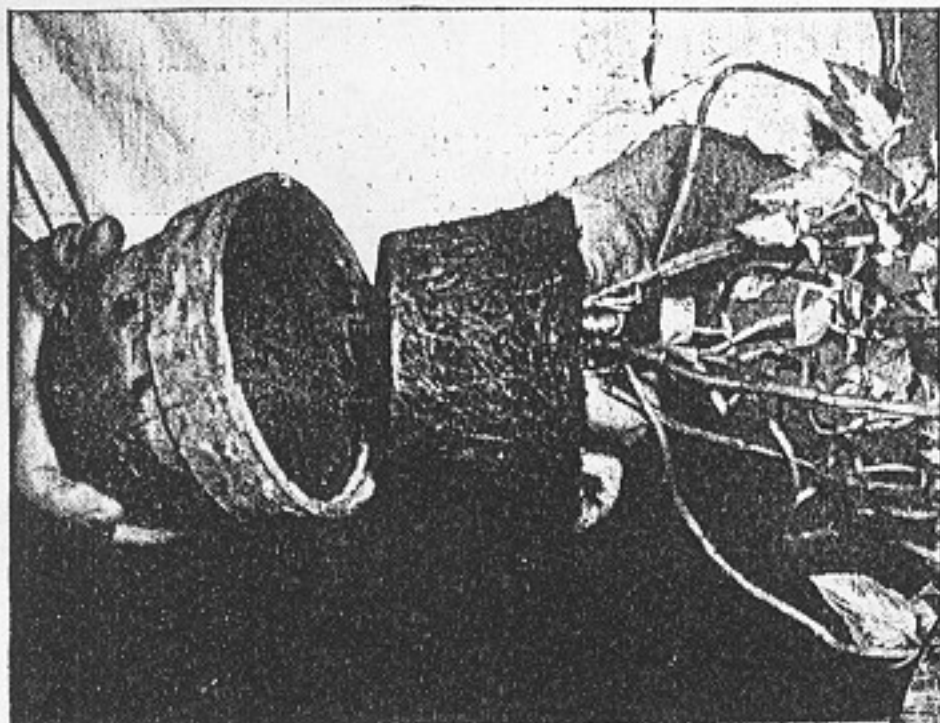


VITAMINS, those wonder-working chemicals, are performing seeming miracles in the plant world, miracles that may revolutionize horticulture, and that have already opened up undreamed of possibilities for the amateur gardener.

Imagine transplanting delicate shrubs with practically no shock or set back, growing shade-loving plants in bright sunlight, returning dying plants and trees to health in a short time, growing huge blooms. Yet all these things are possible for even the rankest amateur gardener, and the only equipment needed is an eye dropper, a measuring jar, a watering



Top, gloxinias planted at same time. One at right was given vitamin treatment. Bottom, vitamin-treated sweet potato (left) grew leaves; one at right, placed in water, grew only roots



Top, vitamin stimulation of root growth illustrated in heavy matting of coleus. Center, in transplanting, roots are placed in solution and dirt removed. Bottom, roots are soaked for twenty minutes, then replanted and watered with heavy concentration of vitamin solution

pot—and a pinch of white crystals.

Those crystals are pure vitamin B₁ which a short while ago began working wonders in the laboratories of the California Institute of Technology. It all started when plant physiologists at the institute began experimenting with the vitamin as a stimulant to root



Vitamin spray gun which automatically mixes 250 gallons of working solution

growth. Soon it became clear that the largest field was in connection with garden flowers and shrubs. For mysterious reasons many ornamental garden plants failed to manufacture sufficient quantities of this vitamin. Most commercial and food crops, however, were found to produce all of the vitamin they could use.

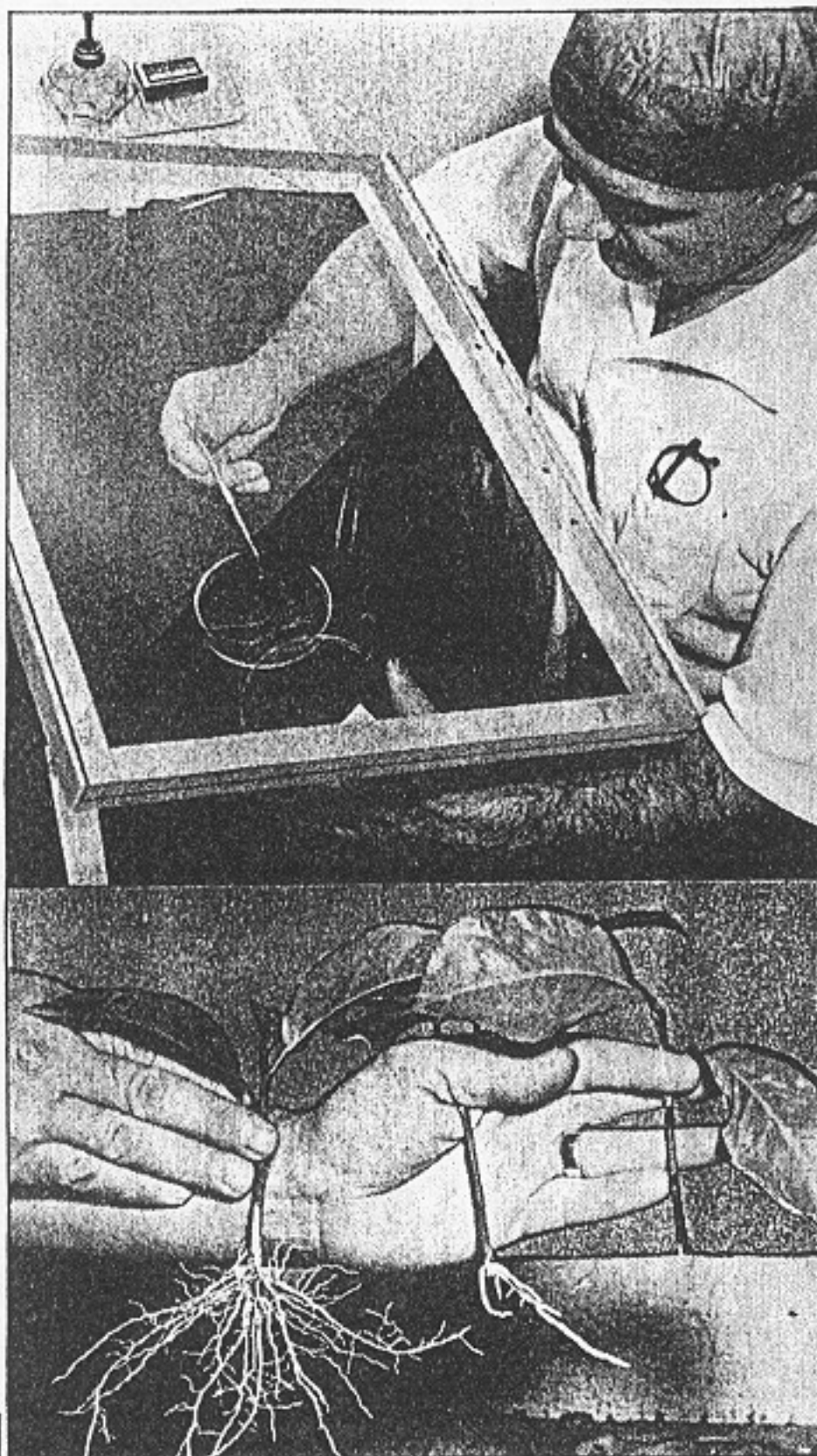
Concentrating on the roots of garden plants, the scientists made thousands of experiments. Minute sections of roots were treated with the vitamin. Rigid precautions were taken to prevent contamination from outside sources. Water in which the roots grew was double-distilled in pure glass stills to prevent contamination from copper pipes. All instruments were thoroughly sterilized and the experimenters used glass screens to deflect their breath from the roots being treated.

Gradually it became apparent that although the primary function of the vitamin was to stimulate root growth, it also had a reaction on the stems and foliage of many plants, increasing their size and the speed of growth.

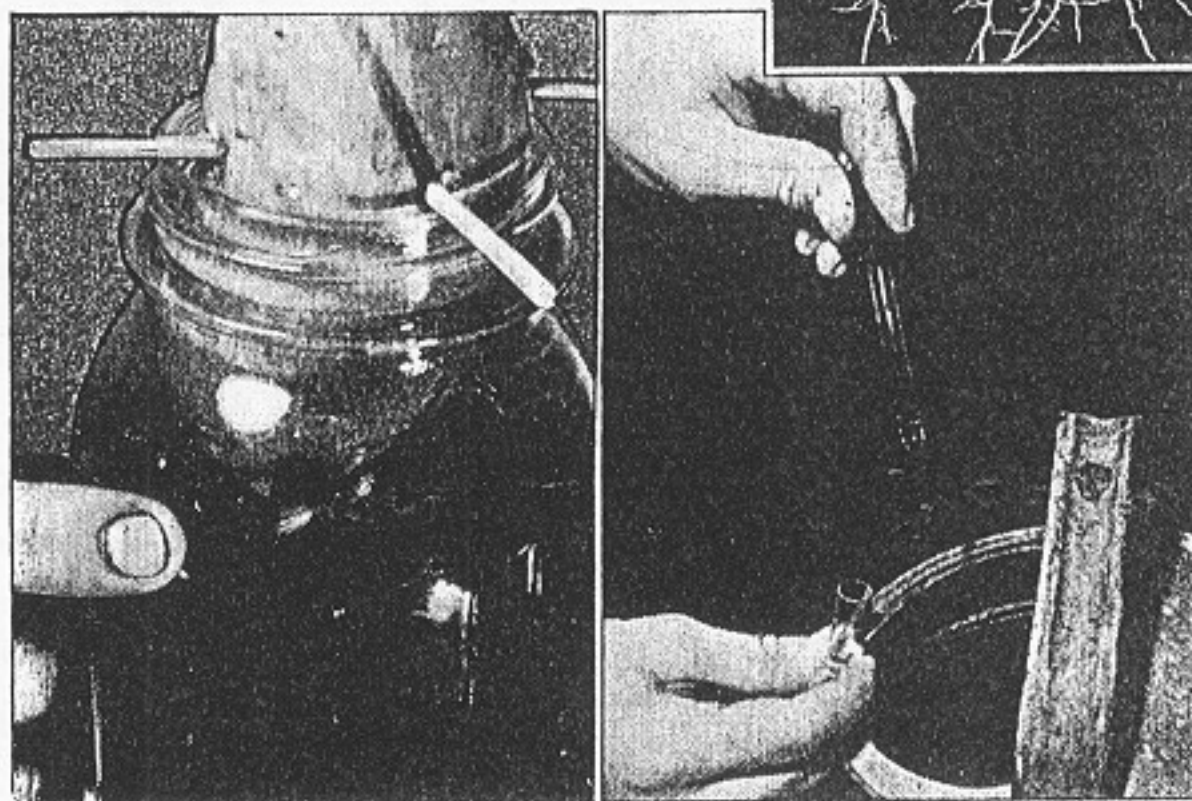
Furthermore, it was discovered that by treating the bare roots of many plants with a heavy concentration, "root shock" could be greatly reduced. Root shock may be compared to the surgical shock which accompanies major operations. Removing a plant from the ground, changing its environment, breaking many of its roots and bruising others, is a pretty major operation as far as the plant is concerned. The result is that it droops, loses its leaves, often dies.

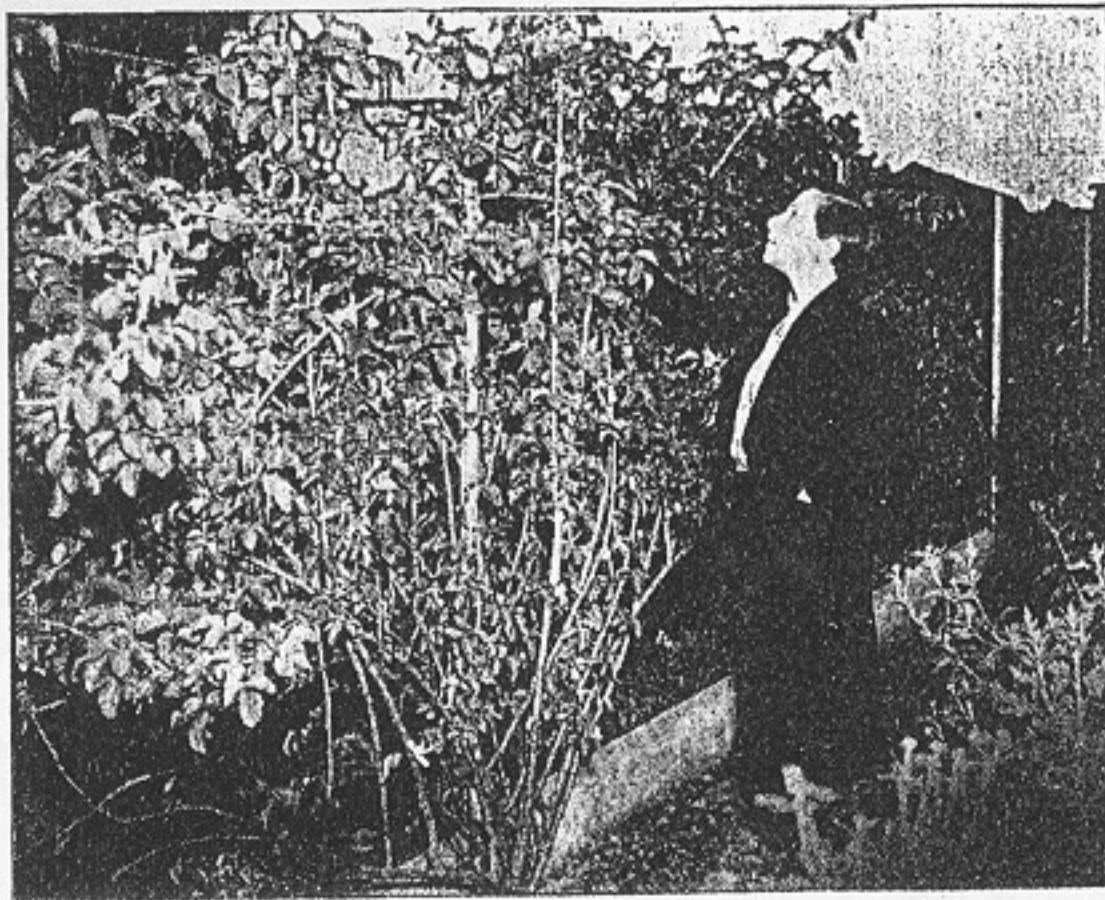
However, if the bare roots of the plant are soaked for a few minutes in B₁ solution, this shock is practically eliminated. Delicate bougainvilleas, which are normally very difficult to transplant, have, after this treatment, been transplanted in hot sunlight. The plants showed no ill effects, whereas control plants which had not received vitamin treatment drooped within a short time.

From the laboratory, experimentation next went into the stage of practical tests. Amateur and



Top, laboratory worker wears sterile cap and uses glass screen to protect plant roots from breath contamination. Center, lemon tree cuttings after five weeks in sand. One at right was fed water, next one was fed indole acetic acid (another wonder chemical) and one at left was fed the acid and vitamin B-1. Note that vitamin-treated cutting has heavy root mat. Bottom, left, how sweet potato is placed in water or solution. Right, using eye-dropper to add one drop of vitamin to one gallon of water





Climbing rose, treated with vitamin, is three times the size of untreated rose planted at same time. Bottom of page, left, all the equipment necessary for vitamin experiments—vial of the crystals, vial for mixing stock solution, eye dropper and a toothpick. Right, tiny amount of vitamin (compared with fingertip) is enough to make twenty gallons of solution

professional gardeners in Pasadena, Calif., conducted many experiments. The results were amazing.

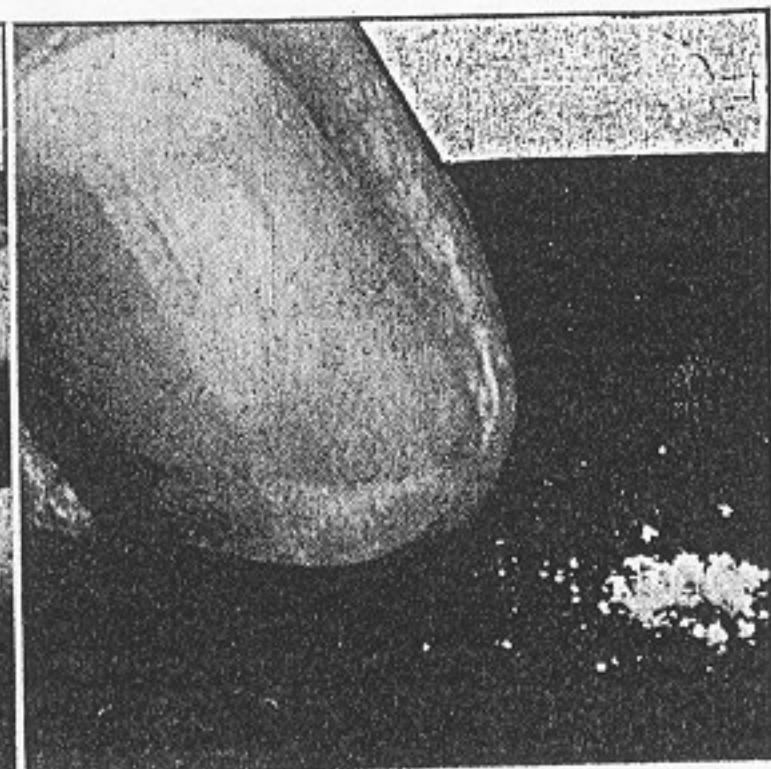
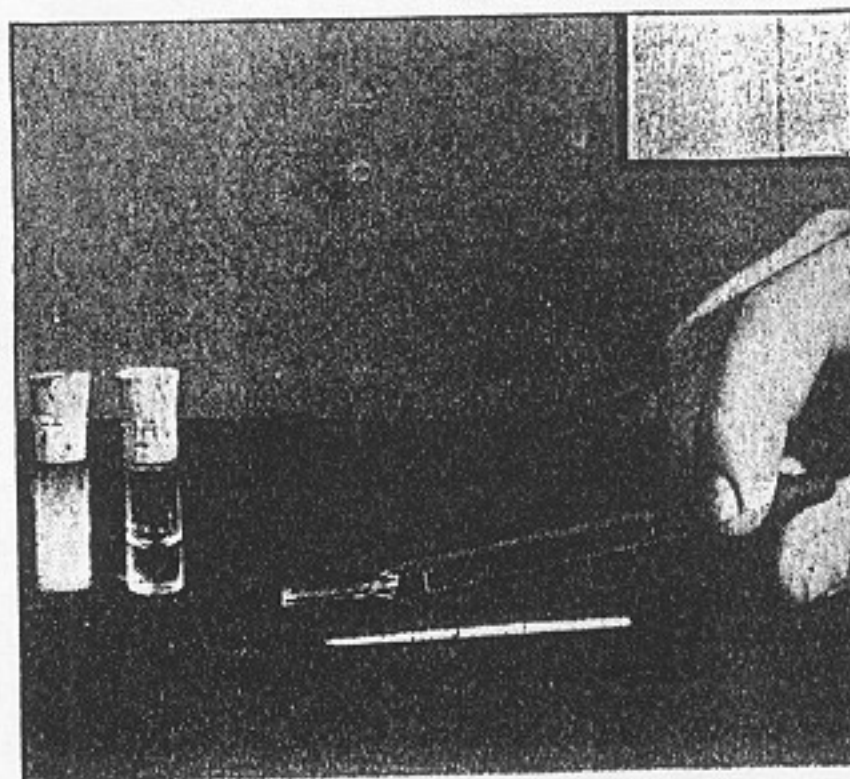
A camellia cutting grew into a fourteen-inch shrub in only eleven months. A narcissus grew to a height of forty-five inches. Vitamin-treated rose bushes grew as if by magic, while untreated ones beside them remained weak and scrawny. In one large rose garden half the shrubs were vitamin treated and half not. The line between the treated and untreated shrubs was as clear

cut as if a magician had touched those on one side with his wand and commanded them to grow.

While the amateurs were achieving such startling results, vitamin treatment began to prove of commercial importance. Although it apparently has no effect on most food crops, it profoundly affects many types of shade and fruit trees. It was tried experimentally on a few trees in an orange grove. Other trees were left untreated as controls. Within a few months, the vitamin-treated trees showed such advance that the idea of controls was abandoned, and all the trees were treated. As the grower

said: "The experiment was such a success that I felt I couldn't afford to let any of my trees go without the vitamin."

One day a shade tree on a Pasadena street was "gassed." The tree was an extremely valuable specimen which had been brought from Tibet. The gassing was caused when a main broke, allowing deadly fumes to seep among the roots. The tree wilted, all the leaves fell. Desperate measures were taken to save it. None of them worked. Just before the tree was given



up for dead, some one thought of vitamin B₁. Hundreds of gallons of vitamin solution were poured around the tree. It was saved.

Two weeks after gigantic eighty-foot palm trees were planted around the new Los Angeles union station, a gale whipped the trees to ribbons. Some were damaged so badly that leaves refused to grow. The trees looked more like telephone poles than palms. Just before they were to be dug up, it was decided to try vitamin B₁. Two hundred gallons of the solution were given each tree. Three months later the palms swayed in the sky, green and healthy.

Such results seem almost uncanny, and yet the methods of using and experimenting with this wonder chemical are so simple that any one can apply them in his own garden. Following are the simple directions:

For equipment all you need is a watering can which holds a measured amount. A two-gallon can is preferable, but a one-gallon size will do. It is difficult to measure a small enough quantity of the solution for any can of less than one gallon capacity. Besides the watering pot, you will need a clean eye dropper (one that forms drops accurately), a small vial to hold the stock solution—and a supply of vitamin B₁ which should be pure synthetic crystals. Your drugstore probably has or can get the pure synthetic crystals. Should you have any difficulty securing them locally, they may be obtained from George C. Warner, Pasadena, Calif. Enough of the vitamin to make 2,500 gallons of solution costs only two dollars. For spreading the solution over large areas, a spray gun which attaches to the hose and automatically measures the solution is helpful.

To mix a stock solution, take only enough crystals to cover the head of a pin. This is approxi-

mately one milligram. An ordinary toothpick will do nicely as an instrument to measure this small amount of crystals. Place the tiny spot of the vitamin in a clean vial and add twenty drops of water. This is your stock solution. Do not make up any more than you need, and keep it in the icebox. If kept cold, it will retain its strength for at least a month; when warm, it deteriorates quickly. The dry crystals will keep indefinitely.

To make a working solution, use one drop of the stock solution to each gallon of water in your sprinkling can. Water plants in the usual manner, and give the same amount of vitamin-treated water that you would of untreated water. For most plants a vitamin treatment once a week is ample. For roses and gardenias the application should be made twice a week. House plants also should be treated twice a week. Lawns should be treated once a week.

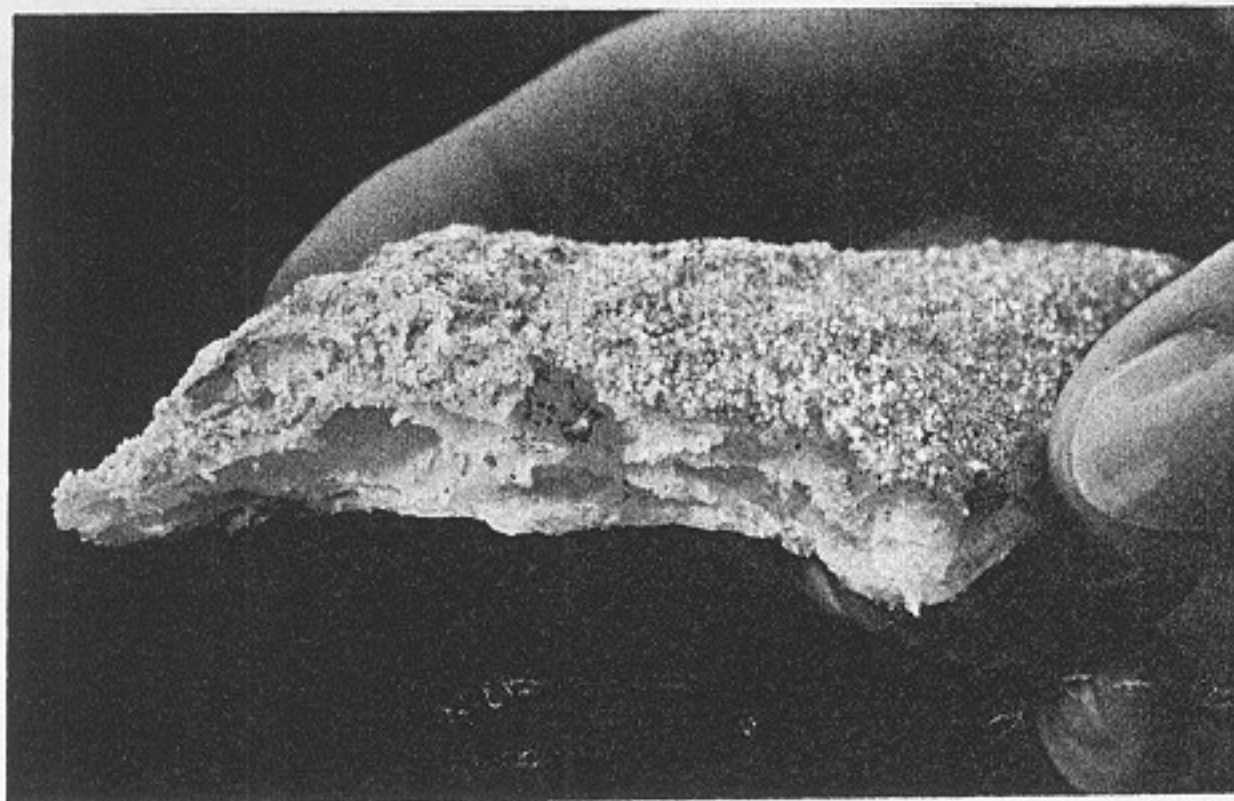
However, when you are treating a plant to prevent root shock during transplanting, you should use a stronger concentration. In this case twenty drops of stock solution should be mixed with one quart of water. The roots of the plant being transplanted should be cleared of dirt and soaked for twenty minutes in the solution. Then plant in the normal way, pressing dirt well around the roots. The solution in which the roots were soaked should then be used to water the plant. Use enough to give a good soaking.

In wet climates potted plants are the best subjects for your first experiments in vitamin feeding, as excessive rains immediately following vitamin feeding are liable to wash away the chemical from the roots of out-of-door plants. This, of course, does not apply to root-shock prevention treatment. In soils very rich in humus, vitamin feeding may be less successful. Gardeners working under such conditions should check their results carefully. Above all, be accurate in measuring and administering the solution, and keep up regular systematic treatment.

Straw Guards Brush Bristles

- To protect the delicate bristles of a small art brush when it's not being used, slip a length of plastic drinking straw over the bristles and part of the ferrule.





The sugar-coated cookies break open to reveal tender, flaky, pastrylike, layers inside

Diamond crisps are flaky, buttery

Unconventional cookies, diamond crisps are made of butter and flour cut together as if you were making pastry, then mixed into a sweet yeast dough. The baked cookies resemble puff pastry in texture and buttery flavor but are considerably easier to make.

A special method of cutting, described below, minimizes handling of the dough and ensures tender, flaky cookies.

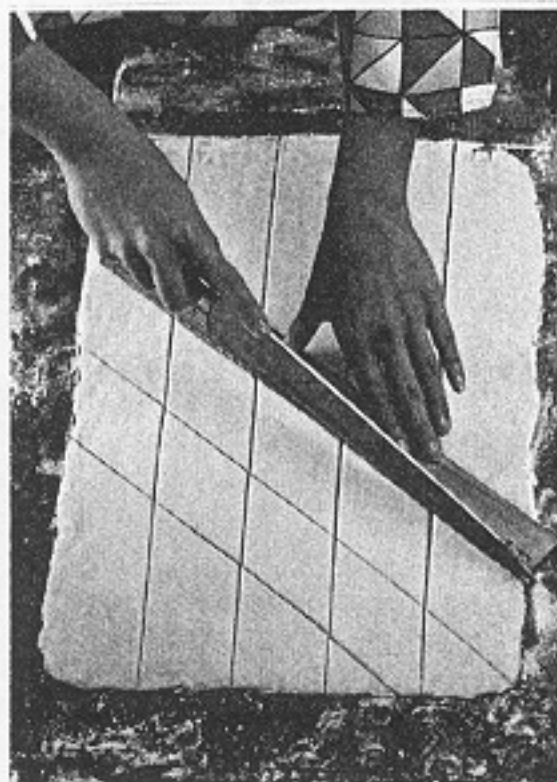
DIAMOND CRISPS

- 3 cups unsifted regular all purpose flour
- 1 cup ($\frac{1}{2}$ lb.) butter (refrigerator temperature)
- 1 package active dry yeast or compressed yeast
- $\frac{1}{2}$ cup warm water (lukewarm for compressed yeast)
- $\frac{1}{2}$ cup sweetened condensed milk
- 2 egg whites, beaten until foamy
- Sugar topping (recipe follows)

Using a pastry blender or two knives, cut together flour and butter until it resembles coarse crumbs. In a small bowl combine yeast with water and let stand until softened; stir in sweetened condensed milk. Gradually add liquid to flour-butter mixture, stirring with a fork until dough forms a ball. Cover and refrigerate until chilled, about 2 hours.

Divide dough in half. Place one portion at a time on a heavily floured board or pastry cloth. Pat ball of dough into a rectangle. Using long firm strokes with a rolling pin, roll out dough from center to edges into a straight-sided rectangle 10 by 18 inches, and $\frac{1}{8}$ inch thick.

With a ruler as a guide, use a sharp knife dipped in flour to cut 5 lengthwise strips 2 inches wide. Then, starting from points



Cut slanted lines across straight-up-and-down cuts to make the diamonds

SUNSET JANUARY 1970

3 inches apart on a long edge, make parallel slanting cuts as illustrated in the picture above.

Use a spatula to lift cookies and arrange on a lightly greased baking sheet. Brush with beaten egg white and sprinkle with sugar topping. Let rise uncovered for 10 to 15 minutes. Bake in a 350° oven about 15 minutes, or until golden. Remove cookies to a rack to cool. Makes about 4 dozen perfect diamonds.

Sugar Topping. Combine $\frac{1}{4}$ cup sugar and 1 teaspoon ground cardamom or cinnamon; stir until blended.



Simple stitchery and appliqué decorate sturdy little bean bags

Clown, tortoise, and Mr. 5 by 5

SUNSET Dec., 1970

Bright bean bags make good stocking stuffers for children on your gift list.

These are stuffed with white rice, which is less lumpy than beans and stings less when it makes body contact.

For each bag, cut a back and front of brightly colored, sturdily woven fabric; these have solid-color fronts and gaily printed backs. Decorate the front with appliquéd felt and wool yarn and embroidery floss.

For example, the little fat man at the top of the picture is drawn freehand, has hand-stitched eyes, nose, and mouth, and a bit of ball fringe for hair. The clown face has felt nose and cheeks machine-sewn in place, buttons for eyes, and embroidery floss for mouth and topknot. The little tortoise has felt feet and tail, small buttons for eyes, and a shell pattern embroidered in yarn.

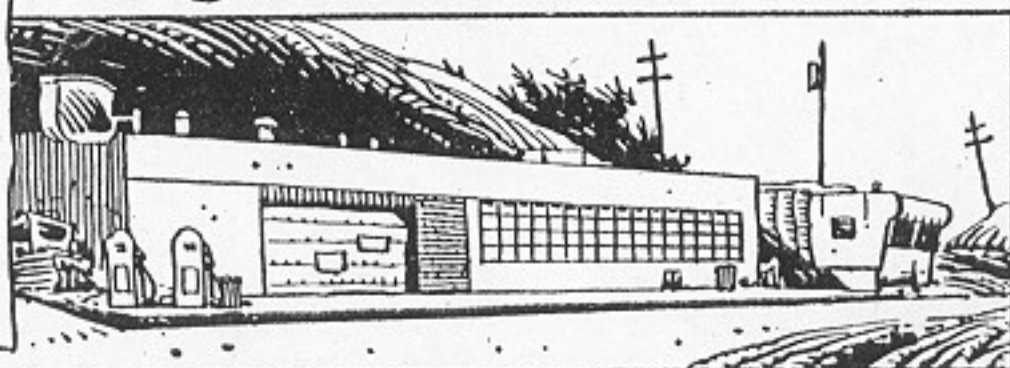
After finishing the decoration, stitch the back to the front with a sewing machine, right sides of fabric together, leaving a small opening along one side for stuffing. Turn right side out, stuff with rice, and sew opening together with tiny, firm stitches by hand.

tales of SURVIVAL

STORY: KURT SAXON
ART: LOMAX

SURVIVAL SCHOOL

WITNESS THE "NEW AGE SURVIVAL SCHOOL", CARSON CALIFORNIA...JUST TEN MILES FROM THE L.A. CIVIC CENTER. IT CONSISTS OF AN OLD GARAGE WITH ABOUT A HALF ACRE OF FLOOR SPACE WITH PARTITIONS SEPARATING THE CLASSROOMS AND A MOBILE HOME, PADDED INSIDE AND OUT, WHICH IS USED AS A MUTED FIRING RANGE.



THIS LESS THAN CHIC SETTING IS OWNED AND OPERATED BY **CAPTAIN JACK**, A PSYCHOTIC EX-GREEN BERET. HIS HAND-TO-HAND COMBAT EXPERIENCE IS AVAILABLE TO ALL COMERS.



HIS PARTNER, AN EX-HOLY ROLLER PREACHER, **DANIEL POMERITT**, PREDICTS ARMAGEDDON WITHOUT THE RAPTURE. HIS ACE IN THE HOLE IS AN UGLY OLD SCHOOL BUS OUTFITTED WITH EXTRA FUEL TANKS AND SUPPLIES FOR A DOZEN PEOPLE FOR A MONTH.



THEN THERE IS "**GIMPY**" TERWILLIGER. HE TEACHES FIREARMS USE AND IS A FAST DRAW EXPERT.



HE WEARS A WOODEN LEG DUE TO HIS GUN OFTEN FIRING BEFORE IT CLEARS HIS HOLSTER.



WANDA JORDON IS A LOUD MOUTHED EX-ROLLER DERBY QUEEN WHO TEACHES FOOD PRESERVING AND KNIFE FIGHTING...SHE IS ALSO CAPTAIN JACK'S MISTRESS.



THE STUDENTS
ARE A
MOTLEY
SELECTION OF
INEFFECTUAL
TYPES MAINLY
WHITE COLLAR
...



AN APPENDAGE OF
THE SCHOOL IS THE
NORDICS BIKE CLUB
WHO DANIEL
CONSIDERS HIS
TWELVE APOSTLES.
THE NORDICS
CONSIDER DANIEL
AND THE SCHOOL
A COVER FOR
THEIR VARIOUS
CRIMINAL
ACTIVITIES.

JUST GETTING TO
THE SCHOOL
BECOMES A
CHALLENGE IN
SURVIVAL...



AND A DEMONSTRATION
IN STATE OF THE ART
...



THE NORDICS COLLECT
SUPPLIES...



AS THE NATIONAL ECONOMY
BREAKS DOWN, LOS ANGELES
BECOMES A JUNGLE WITH
TERRORISTS BOMBING AND
RIOTERS BURNING.



THE OVERALL PLAN OF THE SCHOOL IS TO RELOCATE THE STAFF AND ITS STUDENTS TO OATMAN ARIZONA, THREE MILES ACROSS THE CALIFORNIA BORDER...



THE NORDICS ARE HELPFUL IN DRIVING TRUCKS FILLED WITH SUPPLIES, FROM THE SCHOOL, AND BURGELED FROM AREA STORES.



THE POOR PROTEST BUDGET CUTS BY LOOTING...



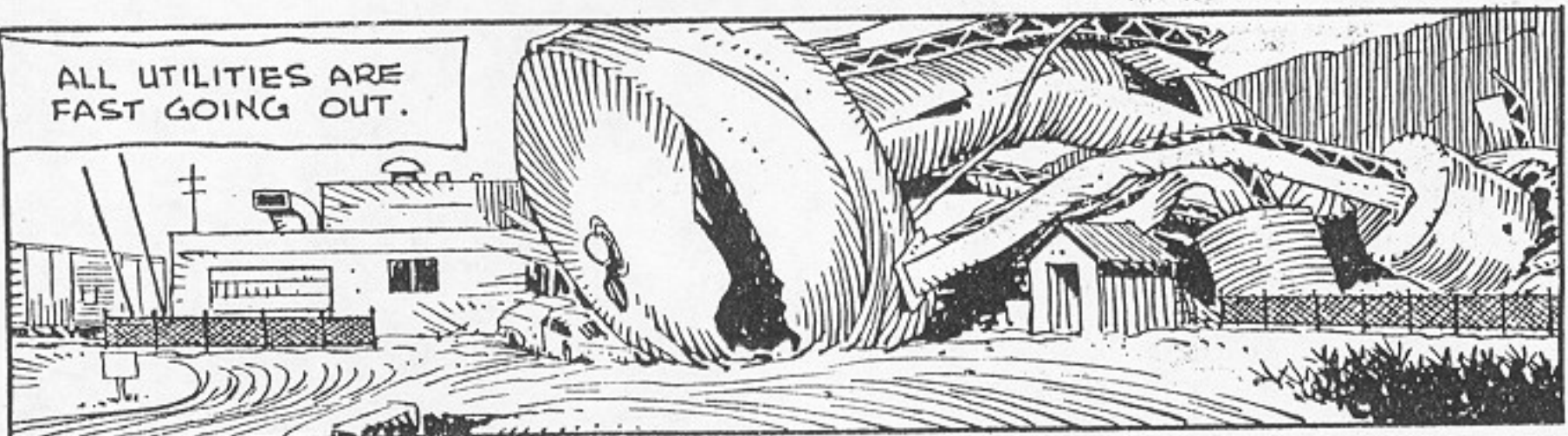
AS THE CITY DIES, POLICE AND NATIONAL GUARDSMEN GUN DOWN RIOTERS AND LOOTERS BY THE THOUSANDS.



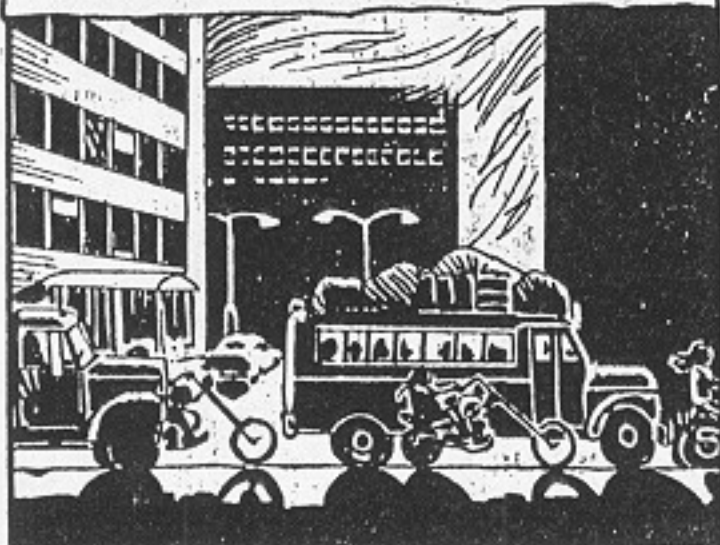
ONE POWER PLANT AFTER ANOTHER IS ATTACKED.



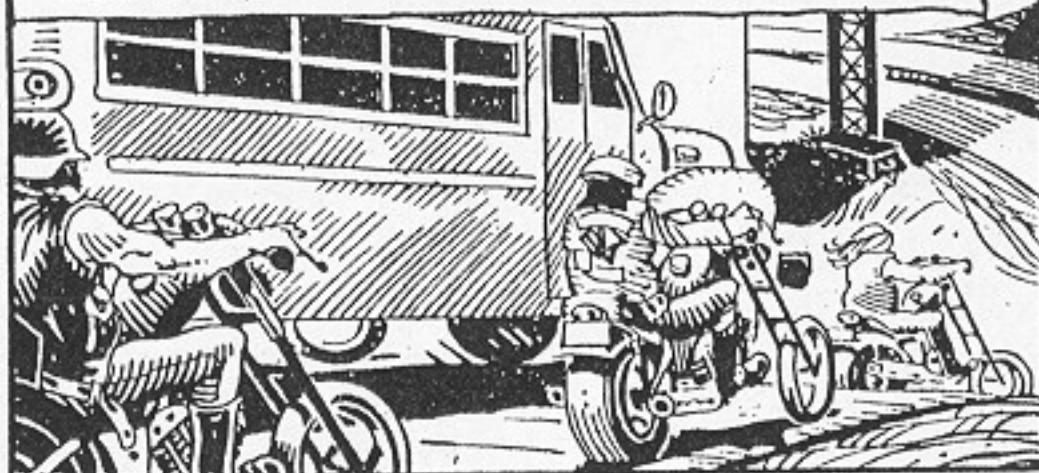
ALL UTILITIES ARE FAST GOING OUT.



AS DOWNTOWN LOS ANGELES GOES UP IN SMOKE THE SURVIVAL SCHOOL STAFF AND STUDENTS PREPARE FRANTICALLY AND MAKE THEIR MOVE.



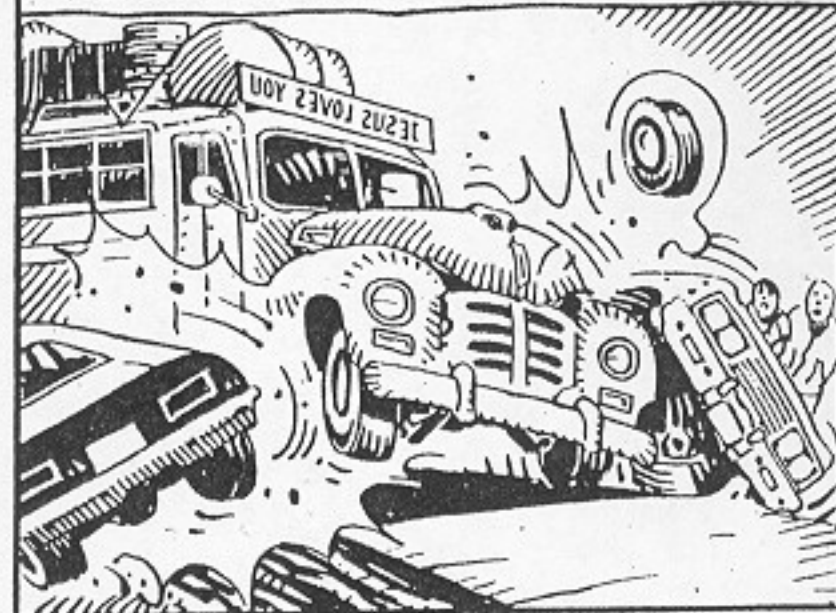
FENDING OFF ATTACKERS, THE LOADED BUS AND THE NORDICS HEAD DOWN DEL AMO TO LONG BEACH FREEWAY.



SEVERAL ACCIDENTS HAVE BLOCKED THE FREEWAY ONRAMP... DRIVERS OF THE STALLED VEHICLES TRY TO COMMANDEER THE BUS AND ARE GUNNED DOWN...



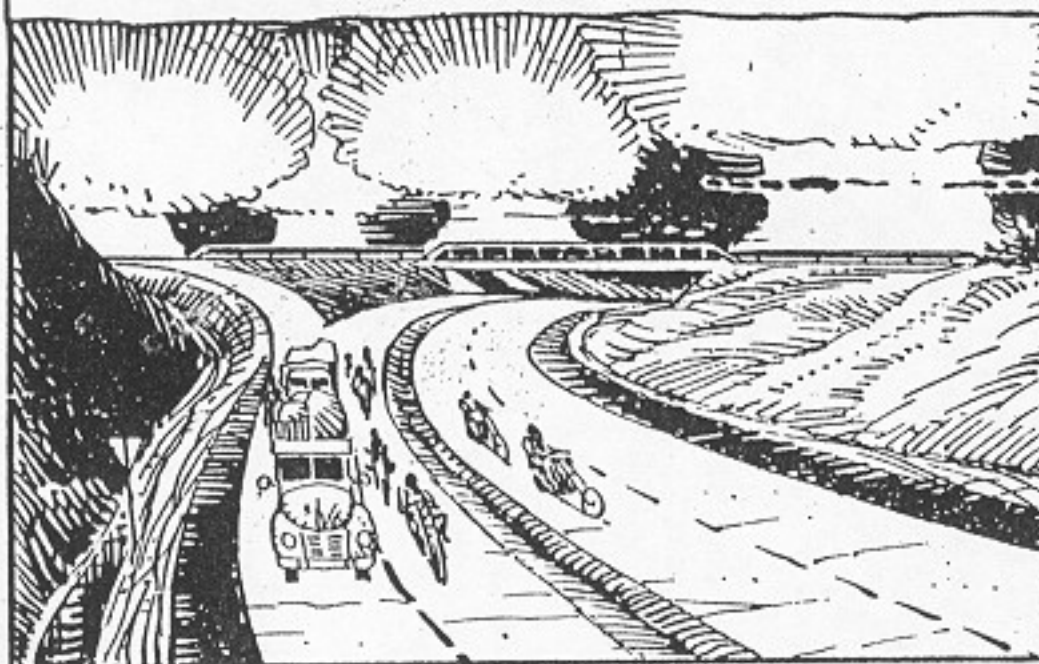
AS THEIR WAY IS CLEARED, A YELLOW ALERT COMES OVER THE BUS' RADIO... MISSILES ARE HEADING NORTH OUT OF RUSSIA.



RED ALERT! RED ALERT!
MISSILES COMING IN!
LOS ANGELES IS BEING
ATTACKED!



FOUR WARHEADS HIT... GONE ARE L.A. INTERNATIONAL AIRPORT, THE U.S. NAVAL STATION, TERMINAL ISLAND, AND THE LONG BEACH NAVAL SHIPYARD...

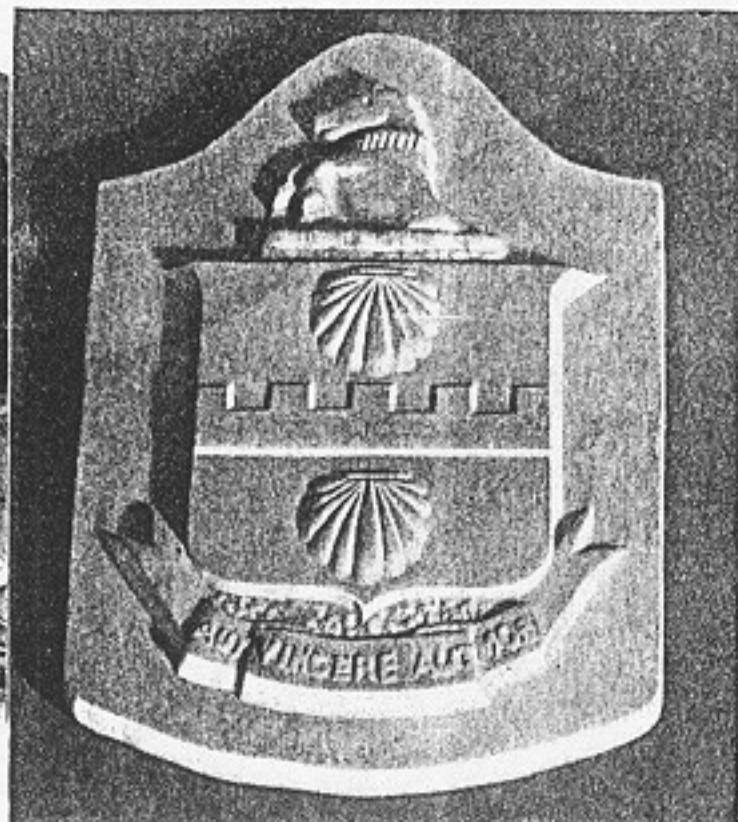


CASTING

Plaster Ornaments

POPULAR SCIENCE MONTHLY
MARCH, 1938

*A new hobby that can be
made to pay cash dividends*



Decorative plaster-of-Paris medallion of heraldic design.
Many such ornaments can be cast in a single plaster mold

By

C. L. NEWCOMB, JR.
and M. W. GIRARD

MAKING decorative plaster casts is a hobby that is not only interesting, but can easily be made profitable. There is a market for the finished product, and a good chance for profit because the actual cost of each article is low. Among the projects that can be made are coats of arms, medallions, book ends, and wall plaques of many designs.

The equipment you'll need is as follows: 1 lb. or more of nonhardening modeling clay, generally called plastine or plasticine; 1 lb. dental or casting plaster of Paris; 1 smooth board 12 by 12 in.; 1 jar vaseline; and a camel's-hair brush, palette knife, cuticle knife, orange stick, mixing bowl, and tablespoon.

A sketch of the coat of arms, or other article to be made, must first be drawn, preferably the size desired for the finished product. Then spread about ½ lb. of the clay over a smooth board in a perfectly smooth

layer about ¾ in. thick. The edges should be trimmed to form the shape desired, such as a square, rectangle, circle, oval, or shield, according to the general dimensions of the

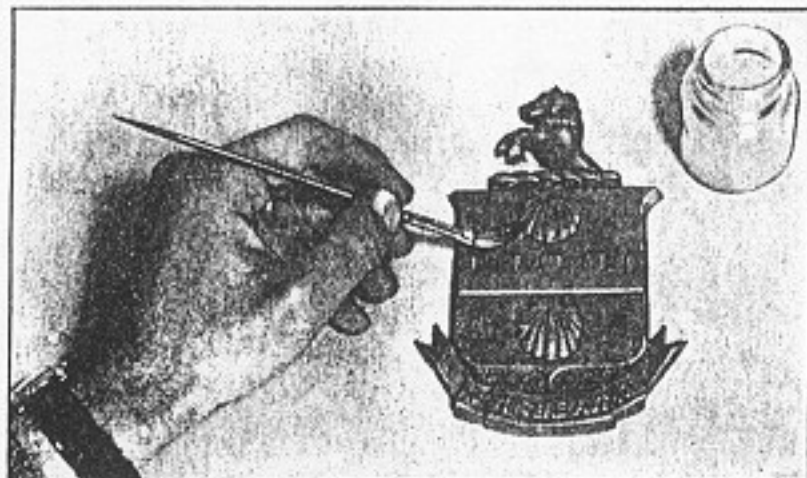
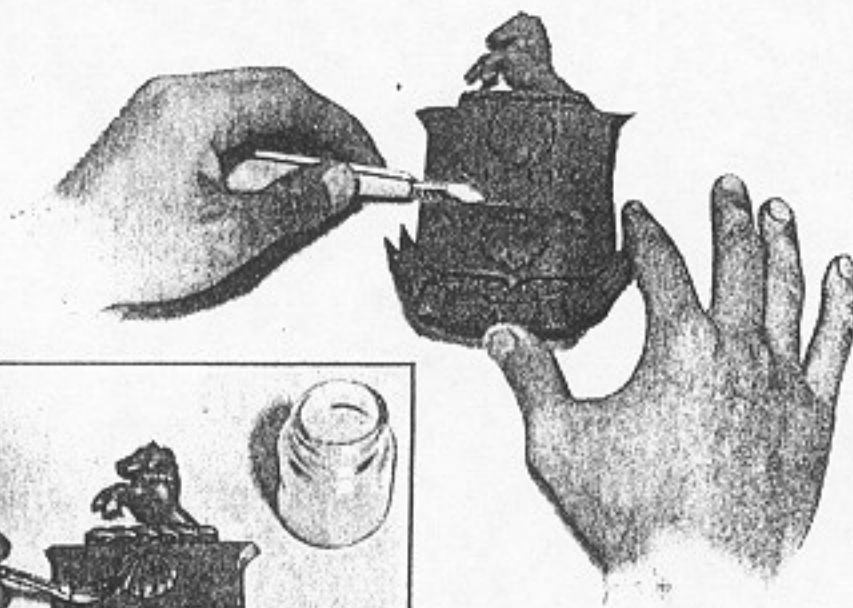
piece to be made.

Using the orange stick (or a pencil), draw every line of the design on the surface of the clay very lightly. Use the cuticle knife to cut this design out, holding the knife at an angle of about 50 deg. so that the edge slants away from the design. This is important in order to eliminate any drag when the cast is made, as will be explained later. Only cut a small piece at a time as the clay has a tendency to tear if too large a piece is cut.

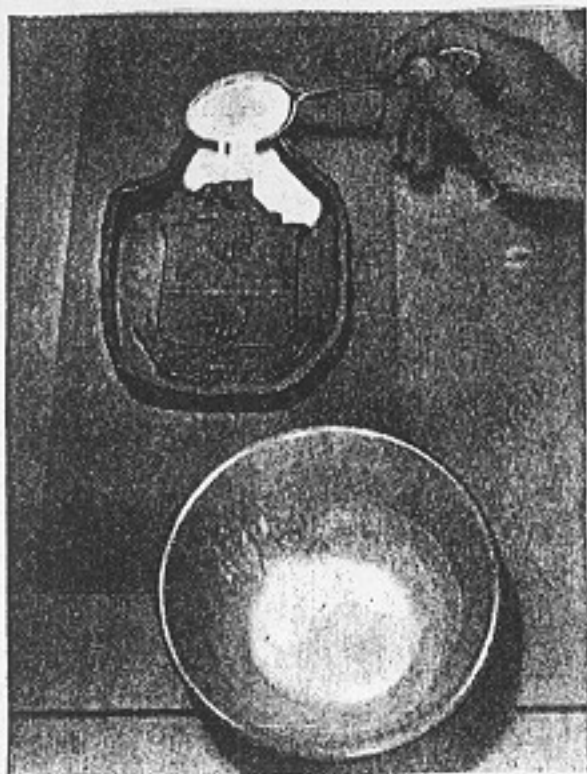
There will be several places that will have to be built up or cut down according to the design. For example, if there is a fess or bar across the shield in a coat of arms, it should be cut out of another strip of clay about ¼ in. thick and placed on the shield in the desired position. In the same manner stars, roses, lions, fleurs-de-lis, and the like must be cut out separately and placed on the shield. In the crest (meaning everything above the shield), the helmet with its crest and mantling should be so carved as to represent one half the article as worn in real life. In some cases it will be a front view and in others, a side view. This is also true in the case of animals, birds, or other figures, whether used in the crest, in the shield, or as supporters on each side of the shield. Heraldic animals and birds should be made as nearly lifelike as possible without losing the artistic effect. Many heraldic beasts and birds, however, have to be distorted or modified to conform to the design by placing an animal's legs in an unnatural position or lengthening the tails of animals or wings of birds.

If there is a motto with the arms, the scroll in which it is inscribed should be carved so as to look wavy, as it would if it were a piece of ribbon.

When the clay model has been cut out, it should be made perfectly smooth all over. The simplest way to do this is to moisten the finger tip and run it lightly over the surface. When it is smooth, take a camel's-hair brush and paint the entire piece with vaseline, being careful to see that the vaseline also is smooth and covers the entire surface as well as a good portion of the board. This



The original design is made from modeling clay by a method that is partly carving and partly modeling. The model is then given a smooth, thin coating of vaseline to prevent the plaster from sticking to it



A wall of clay is set up around the model, and thin plaster poured in to make the mold

is to prevent the plaster of Paris from sticking to the model. Now a wall about $\frac{1}{4}$ in. thick and $1\frac{1}{2}$ in. high must be set up around the whole model. This can be made of clay. Leave about $\frac{3}{4}$ in. between the model and the wall. Paint the inside of the wall with vaseline.

Put about 5 oz. of plaster of Paris into a bowl and add enough water to give a consistency like gruel—just thin enough to pour out of the spoon. This mixture should be stirred until the plaster of Paris and the water are thoroughly mixed and there are no lumps. Pour this into the mold, using the spoon and letting the mixture drip off rather slowly.



The plaster mold. The finger notches are filled with wax before making the final cast

It is best to start in one corner and gradually work away from it, as this will force all air ahead and therefore prevent bubbles from forming underneath. Be sure the mixture gets into every crevice by gently working it with the back of the spoon.

When the entire surface has been covered, fill the rest of the mold to within about $\frac{1}{2}$ in. of the top. In case you have not mixed enough plaster of Paris the first time, you can mix another batch, being careful not to

wait too long. Clean the mixing bowl and spoon with running water as soon as possible.

Depending on the size of the model, it will take up to an hour for the cast to become hard enough to remove. When it has thoroughly set, remove the clay wall. To separate the cast from the model, first take hold of the cast and work it back and forth gently. This will help loosen it. Now take hold of it in two places firmly and pull straight upward.

When the cast is free, take the cuticle knife and trim off all rough spots while the plaster of Paris is still damp.

This intaglio or mold is allowed to dry. The best way to do this is to place it in the sun. The drying can also be done in a very slow oven, but this takes longer.

When it is finally dry and perfectly smooth, cut two notches in each side and one in each end, using the cuticle knife. Now place the cast on the board again and build a wall around it as before. The wall should rise about $\frac{1}{2}$ in. above the top of the cast.

Take a lighted candle and drip wax into

the notches. When the next cast is made, this wax is removed, and the notches become finger grips to enable you to separate the casts. Paint all surfaces of the intaglio, including the waxed notches, with vaseline. Now mix the plaster of Paris and proceed as before, filling the mold right up to the top. In about an hour, the clay wall may be removed and the wax taken out of the notches. Then take the cuticle knife and run it around between the two casts to loosen them a bit. Separate the two, using a firm and steady pull, straight up. If all drag was eliminated in the original model, this will be easy.

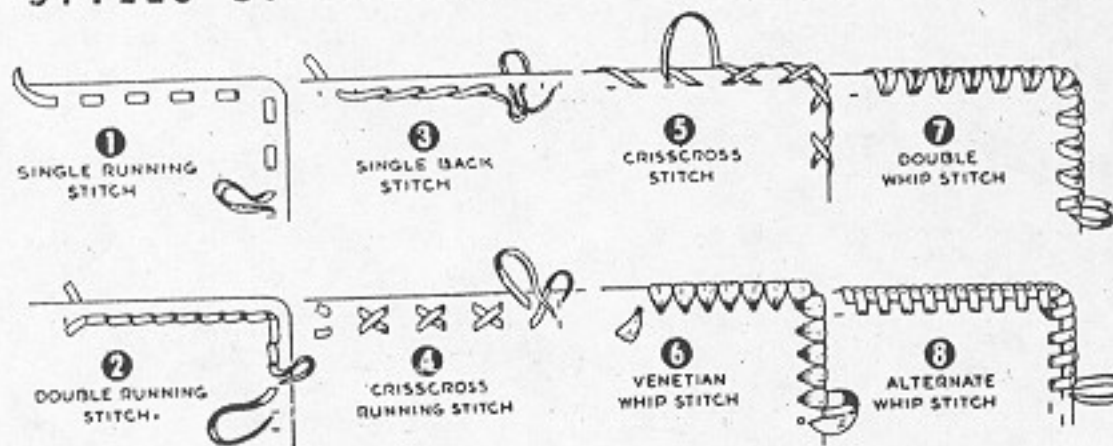
The final cast just made is the bas-relief. It should be trimmed and smoothed with the cuticle knife and very fine sandpaper.

If it is desired to hang the bas-relief on a wall, a wire hanger should be set in the center of the back near the top, just after the plaster of Paris has been poured.

These make attractive ornaments when colored. This may be done by giving the cast about four coats of shellac and then painting it with the desired colors in enamel.

STYLES OF LACING

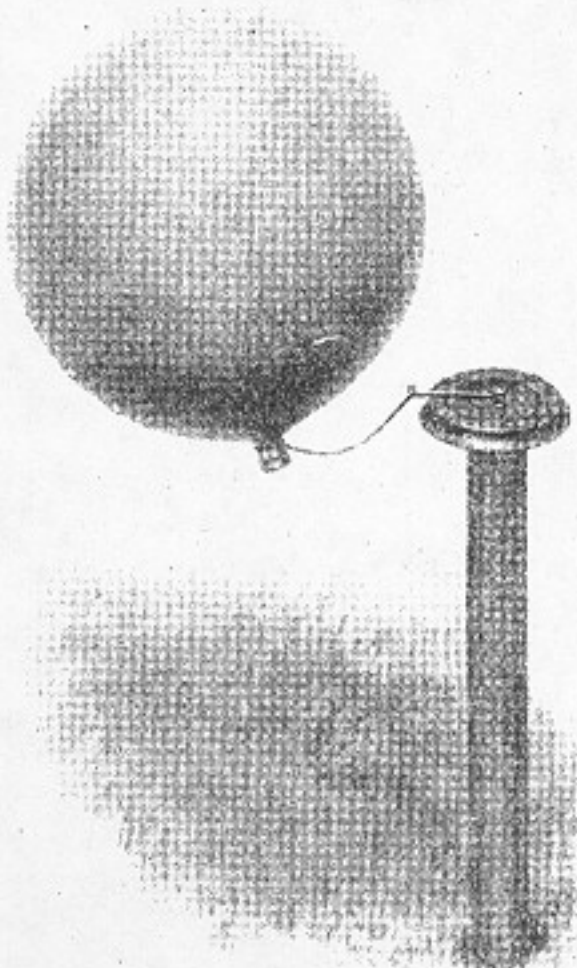
[LEATHER CRAFT]



POPULAR SCIENCE MONTHLY SHOP DATA

1943

BALLOON SCARES BIRDS FROM GARDEN



To FRIGHTEN birds away from a berry patch or a newly planted lawn, where they often do considerable damage in a short time, home gardeners sometimes tie a slightly inflated paper sack to a stick. When it becomes damp, however, the bag is useless, and the string is always getting fouled on the stick. A more efficient and lasting device is shown at the left.

Get a small red toy balloon, inflate it moderately, tie it, and leave the string 4 or 5 in. long. Then drive a stick into the ground and nail on top of it the tin cap of a small preserve bottle or can, letting the head of the nail project slightly. Bend the end of a short piece of stovepipe wire loosely around the nail, and bend another eye in the other end slightly beyond the edge of the tin. Tie the balloon string to the outer eye. As the breeze blows the balloon about, the wire slips around on the tin, and the string cannot catch. It will be found that even rain will not affect the balloon, which will stay inflated for days.—F. B.

Popular Science 1933

Birds can be kept from a newly planted lawn or garden patch by tying a small toy balloon to a stake in such a way that it will bob around and around in the breeze



Popular Mechanics January, 1932

This Model Airplane *Flies like a Bird*

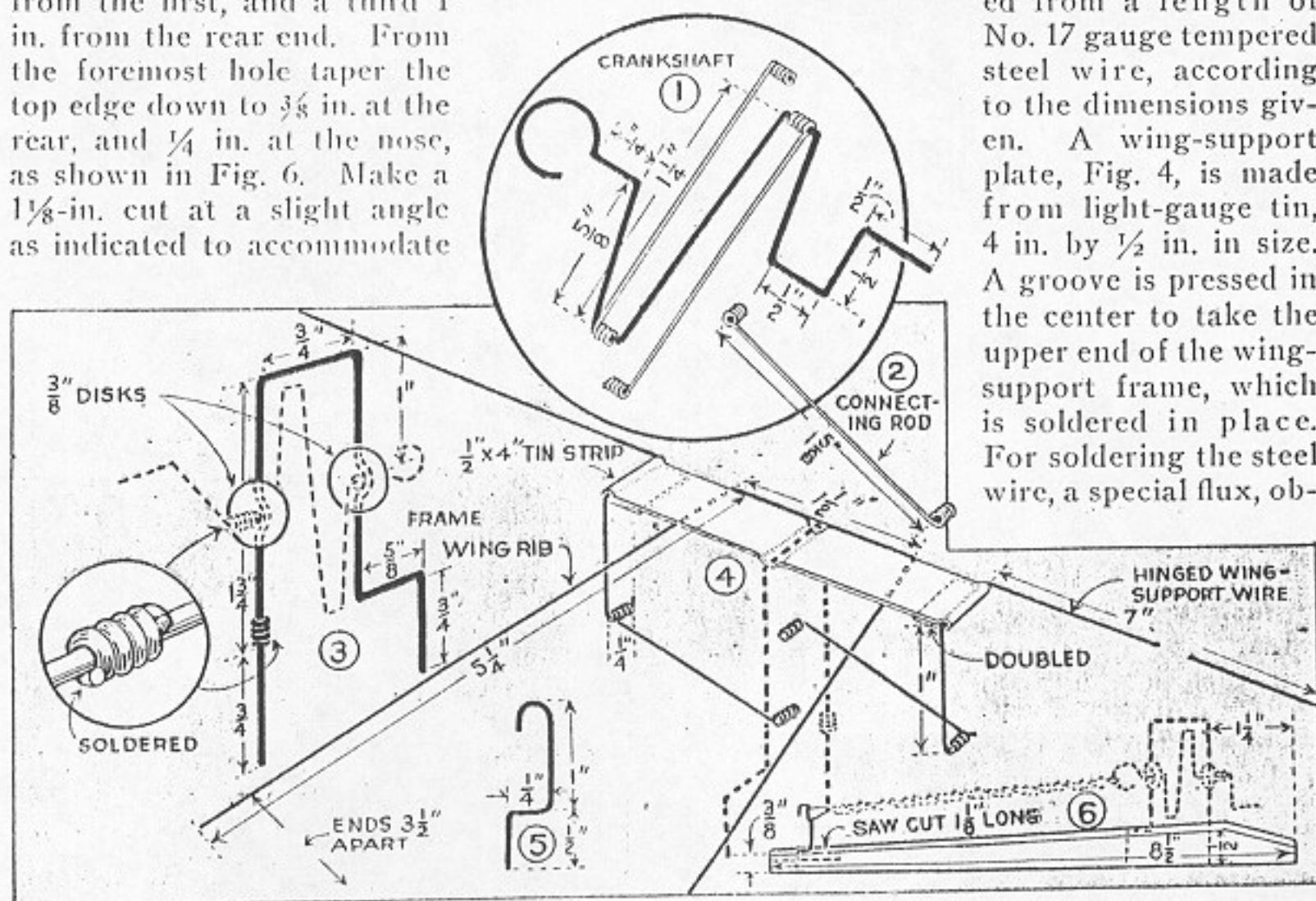
By JAMES B. SLINN

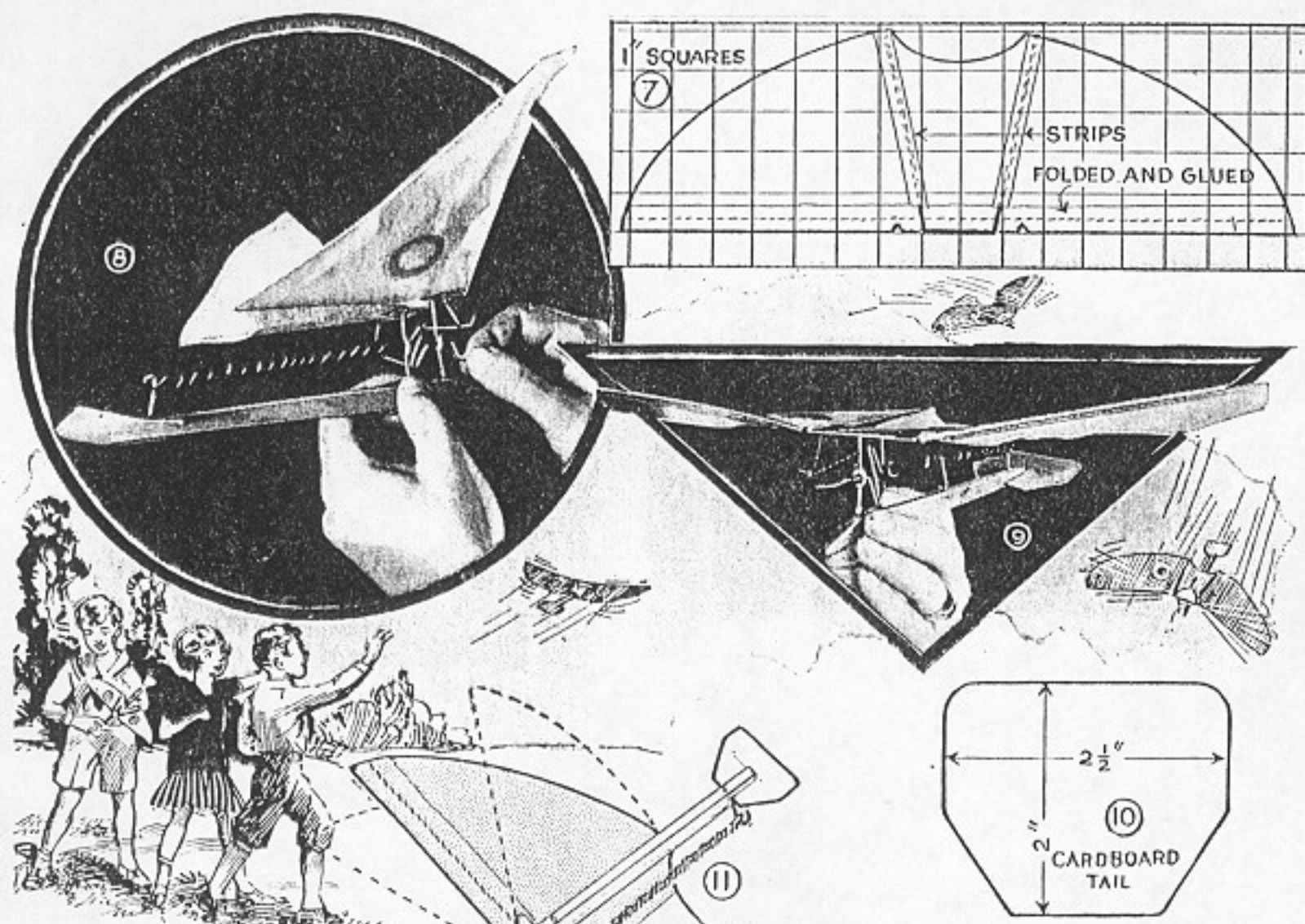
FLAPPING its wings in realistic fashion, this little airplane works on an entirely different principle from the usual type of propeller-driven models. In numerous tests outdoors, planes of this kind have flown for distances more than 300 ft.

For the fuselage cut a piece of basswood or soft pine, $\frac{1}{8}$ by $\frac{1}{2}$ in. by $8\frac{1}{2}$ in. Lay it on one edge and drill a $\frac{1}{16}$ -in. hole $1\frac{1}{4}$ in. from the front end, another $1\frac{3}{8}$ in. from the first, and a third 1 in. from the rear end. From the foremost hole taper the top edge down to $\frac{3}{8}$ in. at the rear, and $\frac{1}{4}$ in. at the nose, as shown in Fig. 6. Make a $1\frac{1}{8}$ -in. cut at a slight angle as indicated to accommodate

the tail. The frame that supports the wing and crankshaft, Fig. 3, is constructed from a length of

No. 17 gauge tempered steel wire, according to the dimensions given. A wing-support plate, Fig. 4, is made from light-gauge tin, 4 in. by $\frac{1}{2}$ in. in size. A groove is pressed in the center to take the upper end of the wing-support frame, which is soldered in place. For soldering the steel wire, a special flux, ob-





tainable at almost any hardware store, is needed. The ends of the tin strip are doubled $\frac{1}{2}$ in. from the end to form hinges for the wing-support wires. Two $\frac{3}{8}$ -in. tin disks with $\frac{1}{16}$ -in. holes in the center, Fig. 3, serve as bearings for the combination crankshaft and rubber-band winder, shown in Fig. 1. Be sure that these disks are perfectly flat. For the crankshaft, which must be made accurately, use No. 18 gauge spring steel wire and bend to the size and shape indicated. Then coil the connecting rods, which are made from No. 20 gauge spring steel wire, to the size given in Fig. 2, around the crankshaft. Place the two disks over the crankshaft and solder in place to the main frame, which is bent to permit centering the crankshaft, as indicated by the dotted lines in Fig. 3. Form a bushing for the crankshaft and motor support as shown in the detail accompanying Fig. 3 and solder this in place. A similar bushing on the main frame serves as a stop against the fuselage. The construction of the wing ribs is given in Fig. 4. They are made by bending a length of No. 20 gauge oil-tempered or spring steel

wire to a U-shape, $1\frac{1}{2}$ in. wide at one end and $3\frac{1}{2}$ at the other. Note that the wing-support wires are bent in opposite directions. Now attach the main frame to the fuselage and apply a drop of solder to the ends projecting from the underside, to prevent loosening.

The tail is cut from a piece of cardboard, $2\frac{1}{2}$ by 2 in., as in Fig. 10. Round the back corners neatly and cut the front to $1\frac{1}{2}$ -in. width at the center. Construct the rear rubber-band support from No. 17 spring steel wire, Fig. 5, insert the lower end through the holes at the rear of the fuselage, and apply a drop of solder to keep it from being pulled out. In making the wings, use a light, tough parchment paper and cut to size as shown in Fig. 7. Turn over the front edge $\frac{3}{4}$ in. and sew or paste down, leaving an opening large enough to admit the wing-support wires. Also cut notches as indicated in the drawing. Turn the device on its back and fasten the two rear ribs to the wings with $\frac{1}{2}$ -in. gummed paper tape. Glue the part between the hinges to the

tin plate, and place the wing-support wires in the open hinges, after which the latter are closed. Be careful not to make a joint that will bind. The connecting rod on the right goes to the front crank and that on the left to the rear crank. The attachment and alinement of the connecting rods are highly important; if they are not exactly the same length from center to center of the bearings at the ends, the finished craft will not work properly, if at all. All joints must be free in order to minimize friction. A $\frac{1}{4}$ -in. strip of rubber band, about 5 in. long when doubled, which may be cut from a discarded inner tube, serves as the motor.

The plane is now ready for trial flight. Hold it in the left hand and wind about 30 turns with the right, as in Fig. 8. When wound up, place the forefinger of the left

hand against the back crank, as in Fig. 9. Pointing the model slightly upward, give it a light push and let go quickly. If it has a tendency to climb too steeply, the tail should be bent down just a trifle, and if the plane tends to fly downward, raise the tail sufficiently to correct this fault. Both wings must lift equally to make the plane fly straight. If the right wing support is bent slightly forward at the hinge, the plane will turn toward the right, while if the left wing is forward, the course will be toward the left. The fuselage should be at right angles to the front edge of the wings, and the wing ribs should extend horizontally in line with the fuselage. Several trial flights will probably be necessary before the proper adjustments are obtained.

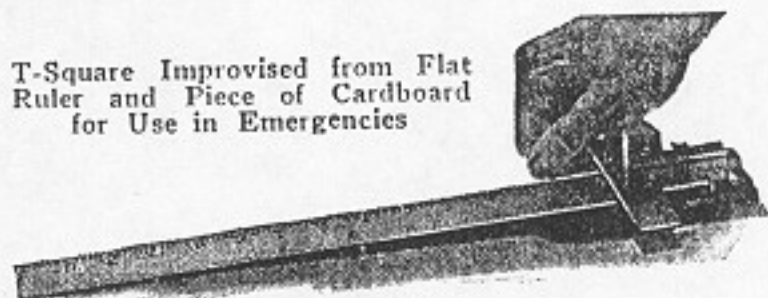
Salt-Water Bath for Goldfish

To keep goldfish in healthy condition, it is a good idea to give them a salt-water bath once a week. A teaspoonful of salt to a gallon of fresh water is sufficient, allowing the fish to remain in it for about five minutes.

T-Square Improvised from Ruler and Cardboard

A satisfactory T-square can be improvised by fastening a small piece of card-

T-Square Improvised from Flat Ruler and Piece of Cardboard for Use in Emergencies



board across the end of a ruler. A double piece of cardboard will give the square a better grip, or a soft piece of $\frac{1}{8}$ -in. wood can be used.



Garlic popping

Instead of taking time to peel a clove of garlic with a knife, try this quick method of popping the clove from its skin.

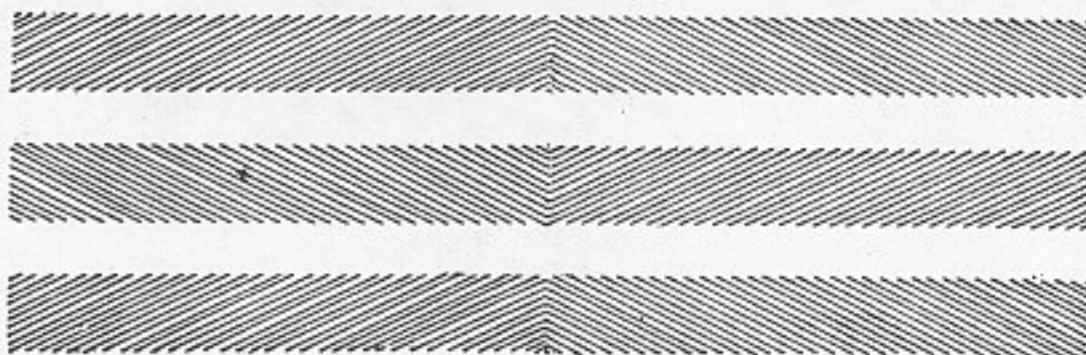
Place clove of garlic on a chopping board. Cover it with flat side of a broad bladed knife. Hit—not too hard—the top side of the blade with your fist. The garlic skin bursts. Lift clove from burst skin.

Magazine Of Useful And Entertaining Knowledge
February 1831

IMPROVED PREPARATION OF CANDLES.

Steep the cotton wick in lime-water, in which is dissolved a considerable quantity of nitrate of potash. By this means is obtained a purer flame, and a superior light—a more perfect combustion is ensured; snuffing is rendered nearly superfluous, and the candles thus treated, do not run. The wicks should be thoroughly dry before the tallow is put on them.—*Phil. Jour.*

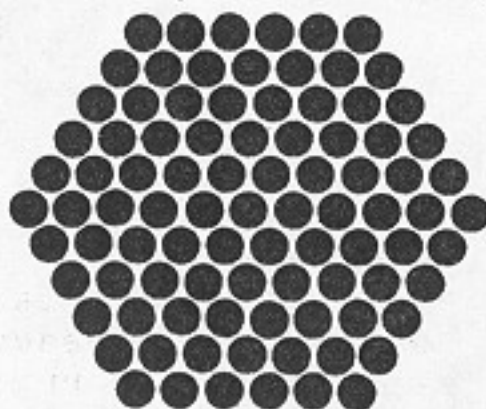
CAN WE ALWAYS BELIEVE OUR OWN EYES?



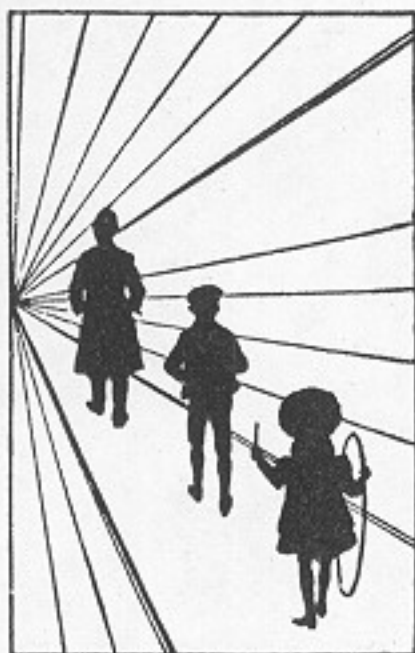
If you fix your eyes on the two white spaces between the lines it will appear as if the top space becomes wider at the

ends, and as if the bottom space becomes wider in the middle. But both lines are perfectly straight.

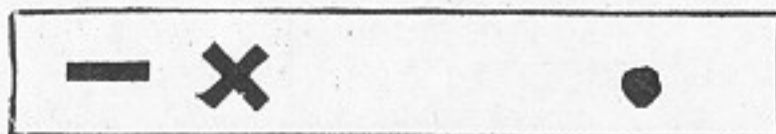
Which line is the longer?
The black line on the right
appears longer than the line
beside it, but both lines are
exactly the same length.



This shows how a circle appears to have sides and corners. These black spots, if looked at intently, seem to have six sides, like a honeycomb, but they are all quite round.



Who is the biggest? The policeman, most people would say. But the policeman is really the smallest and the little girl is the biggest. This curious effect was first used by a clever artist for Pear's Soap.



There is a blind spot in both your eyes—part of the eye, that is to say, is blind. You can prove this by closing your left eye and looking at the X with your right. Hold the paper a foot away, and draw it towards you. Though looking at the X, you will see the spot too, but at a certain point the spot will disappear. By drawing it still nearer to you, you will bring the spot into view again.



Which square is the larger? Most people would say the white, but the white is smaller than the black.



Turn the page round
and round to the left.
The plain rings will
appear to revolve

rapidly to the left,
and the others to go
slowly round in the
opposite direction.

One of these sets of lines looks higher than it is wide, and the other wider than it is high, but both are square.



POPULAR SCIENCE MONTHLY

DECEMBER, 1931

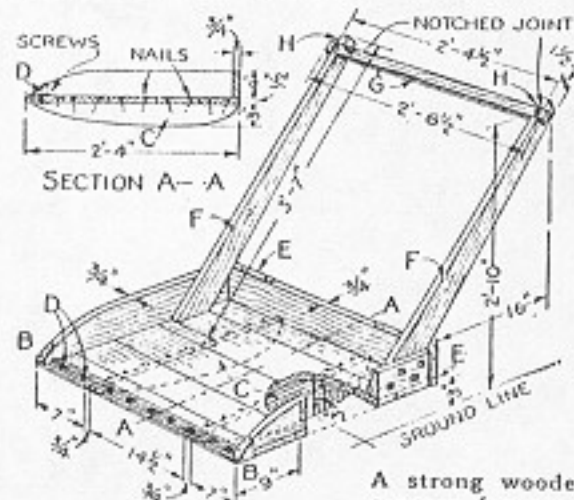
SCOOP ON RUNNERS AIDS IN REMOVING SNOW



SNOW may be easily scraped up with this scoop and pushed out of the way. If it can be dumped on to a lower step or terrace, a large area may be quickly cleared.

Cut out two sides of ash or other light but hard wood, $\frac{3}{4}$ by 4 by $27\frac{1}{4}$ in., and the back $\frac{3}{4}$ by 4 by $28\frac{1}{2}$ in. Shape the sides as shown and nail together at the corners. Make the bottom of pine or other light wood, $\frac{1}{2}$ by 28 by 30 in., using three or four pieces, preferably with a piece of hardwood at the front edge, which will receive hard usage. Shape this edge to continue the form of the sides, and fit a piece of 22-gage galvanized iron 5 in. wide and about 36 in. long to protect it, bending the ends over and fastening them to the sides as at *B*. Fasten the edges with $\frac{3}{4}$ -in. tinned trunk nails as at *D*, driven through from both sides and well clinched.

Get out two hardwood runners *C*, $\frac{3}{4}$ by 3 by 28 in., and shape them about as shown. Fasten them at the front with screws, and nail the bottom strongly to their top edges with fivepenny common nails. Bend two iron straps *E*, $\frac{3}{4}$ by 16 in., and fasten them with fourpenny nails to strengthen the back corners. Make two ash push bars *F*, $\frac{3}{4}$ in. thick, 43 in. long, and tapering in width from 3 to $1\frac{1}{2}$ in.; also one ash cross handle *G*, 1 by $1\frac{1}{2}$ by $30\frac{1}{2}$ in. Notch the edge of the sides *F* and fasten *G* with $1\frac{1}{2}$ -in. No. 12 screws as at *H*. Round and sandpaper all corners of *F* and *G* and give them one or two coats of varnish.—A. K.



A strong wooden
scraper for snow

CORN AND BEANS, THE WONDER FOODS

by Kurt Saxon

Corn and beans have been staple foods for thousands of years. Those American Indians who farmed grew corn, beans and squash as the main elements of their diets. All three are easy to grow, are very productive, filling and nutritious. In fact, one could live on these three foods, and many have had to.

While researching this article I talked to many Southerners who remembered corn and beans as their mainstays as children during the Great Depression. Cornbread and cornmeal mush and beans were always there, regardless of their poverty, and they thrived!

If you have a supply of corn and beans you'll never hunger. Moreover, they taste good. They can also be mixed with any other food, adding bulk and flavor to the most humble meal.

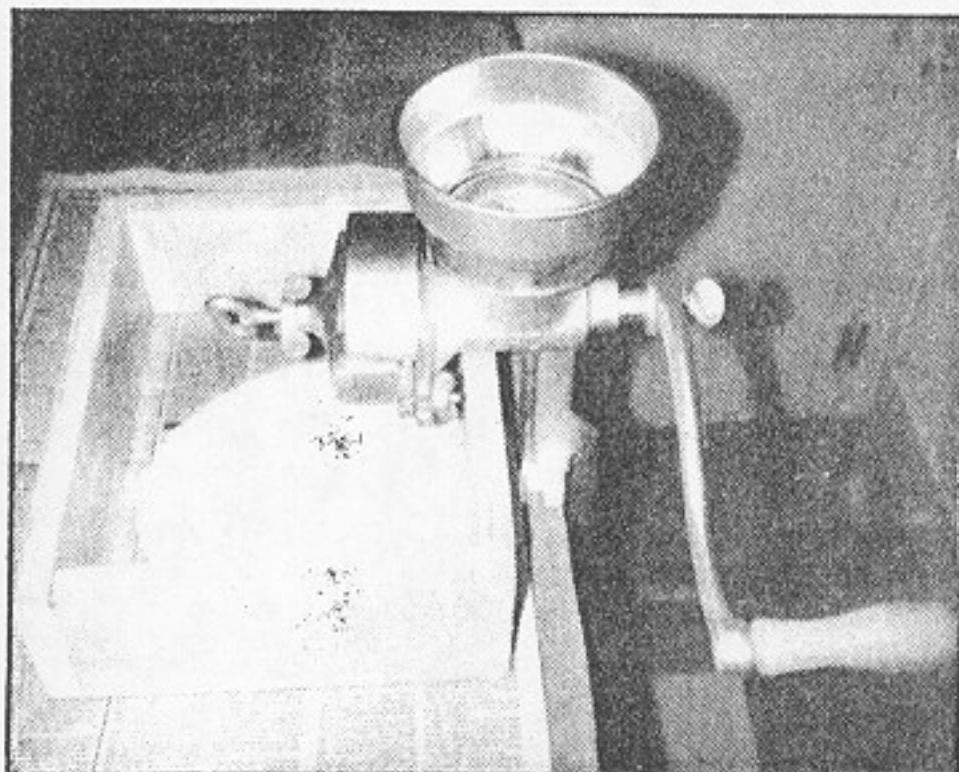
To utilize corn, buy it in 50 pound sacks for about \$3.50 from your local feed store. You'll also need a Corona Grain mill. I sell them as a convenience to my customers. The mill will be one of your most important survival tools.

When you get your corn, transfer it to plastic bags, gallon jars, etc., as weevils will come from all over to eat it.

Don't bother trying to sprout the corn as it's most likely hybrid and so only about one grain out of ten will sprout and the rest will only rot.

GRINDING CORN

With my Corona Grain Mill I can grind a pound of whole corn in five minutes. I put the pound in the



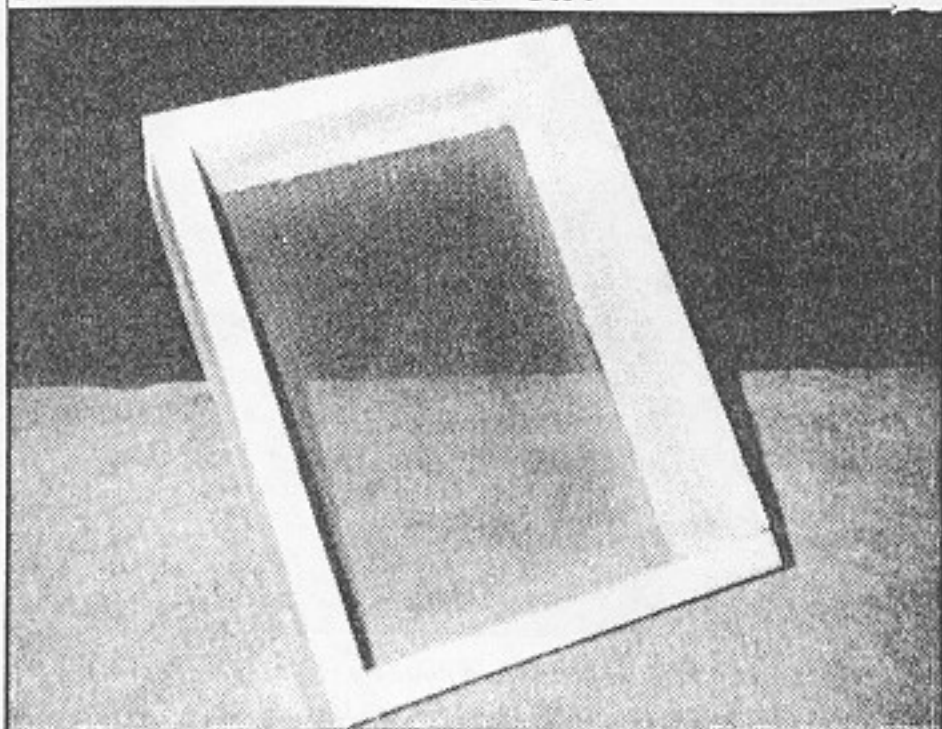
CORONA GRAIN MILL

hopper and set the screws to a very coarse grind which only cracks the kernels into five or six pieces each. Then I adjust the screws a little tighter to grind the pieces finer. Then again and again and once again. This makes grinding easy.

Since most recipes take a pound or less, grinding by the pound insures freshness. Of course, you can grind several pounds at a time, but that's work. If you set up your mill permanently in a place of its own, you can grind routinely with no thought of time consumption or hard work.

GRINDING SCREEN

Away I came up with to make the grinding easier is a box screen. This is a four-sided, bottomless box of 3/4 by 4 inch wood. Mine is 12 by 12 inches. I used plain aluminum window screen, as that's as fine as bread flour or cornmeal needs to be. I spread GOOP, plastic glue around the rim and pressed the screen on.



GRINDING SCREEN

I put a section of newspapers under the grinder head and put the screen on the newspaper and under the grinder head. After each grinding stage I shook the finer meal through the screen onto the newspaper and then transferred it into a bowl. This saved sending the finer meal back through the grinder.

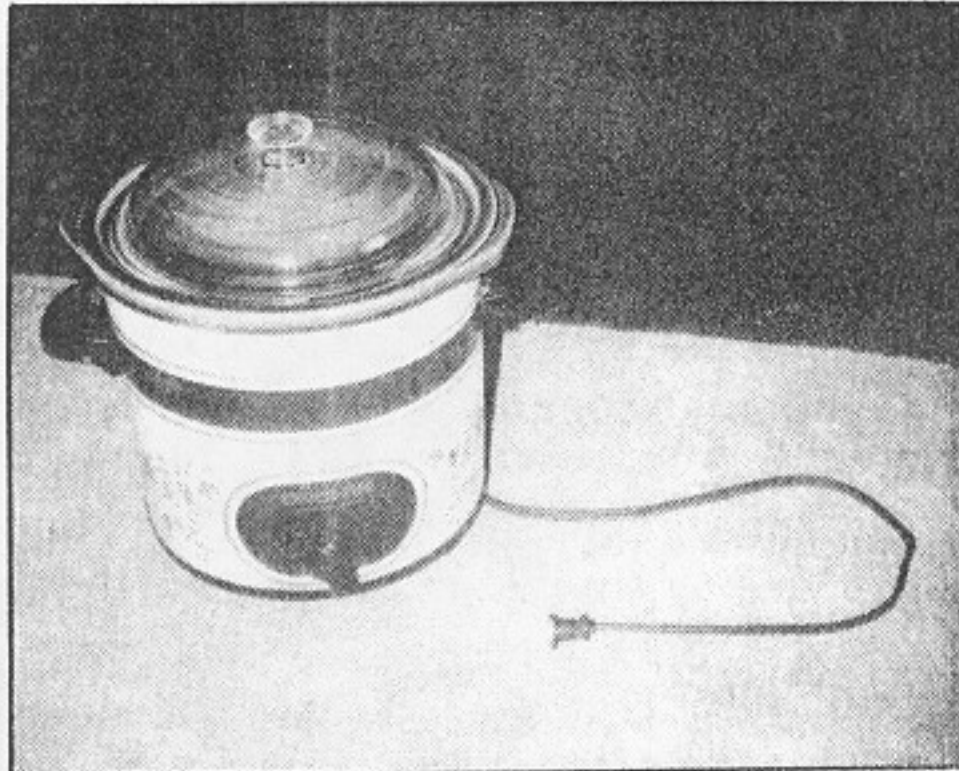
You can also use the screen for anything else, as the GOOP gives the screen a permanent and strong bond to the wood.

CORNMEAL MUSH

Your first project should be cornmeal mush. Consider, as you read, how cheap and simple it is to make.

The best way to cook cornmeal mush is in a

Crock-Pot. They cost about \$20.00 at Wal-Mart or most other stores. They last forever and use only about 10¢ electricity in 24 hours. They cook slowly and will not burn the contents. You can start a batch of whatever before leaving for work and when you get home you'll have a fully-cooked hot meal waiting. The instruction booklet shows you how to do all your cooking in a Crock-Pot, cheaply and great-tasting. Get one!



CROCK POT

Without a Crock-Pot you need a double boiler. Corn will stick hard over direct heat and so you must not cook it over direct heat.

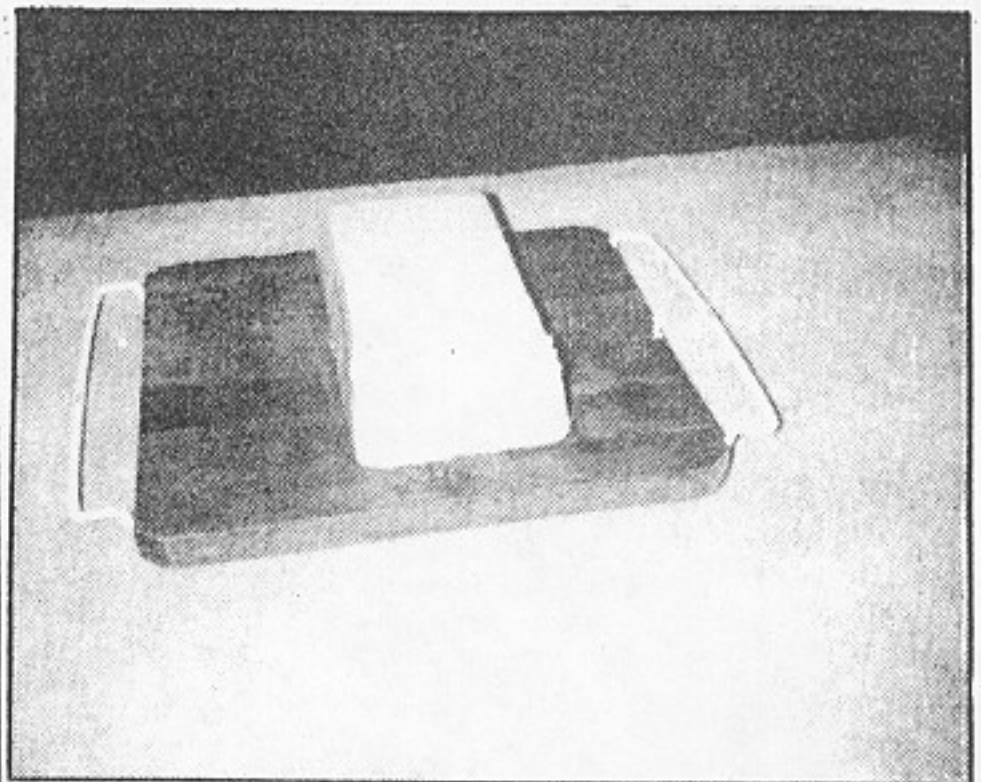
A double boiler is simply two pots, the bottom one filled with water and the top holding whatever you don't want direct heat applied to.

Say you have a crock-pot. Put in $5\frac{1}{2}$ cups of cold water and pour in and stir 2 cups of cornmeal and a tablespoon of salt. You can add whatever spices or herbs you like for flavor or leave it plain. Turn the Crock-Pot on high and put on the lid. Then let it cook for 3 hours.

After one hour stir it well with a table knife and scrape off any cornmeal sticking to the sides, as that's where the heating elements usually are. Cornmeal does stick slightly in a Crock-Pot, but it's easily scraped off.

After the second hour give it another stir and scrape and let it alone. After the third hour, scrape and stir again and pour the mush out into a greased or Teflon-coated bread baking pan.

Let it alone for a few hours or overnight. It will then be set firm and you can turn it out on a plate. Then cut off quarter-inch slices and fry it golden brown and serve it with whatever else you have. It tastes good, is nutritious and filling.



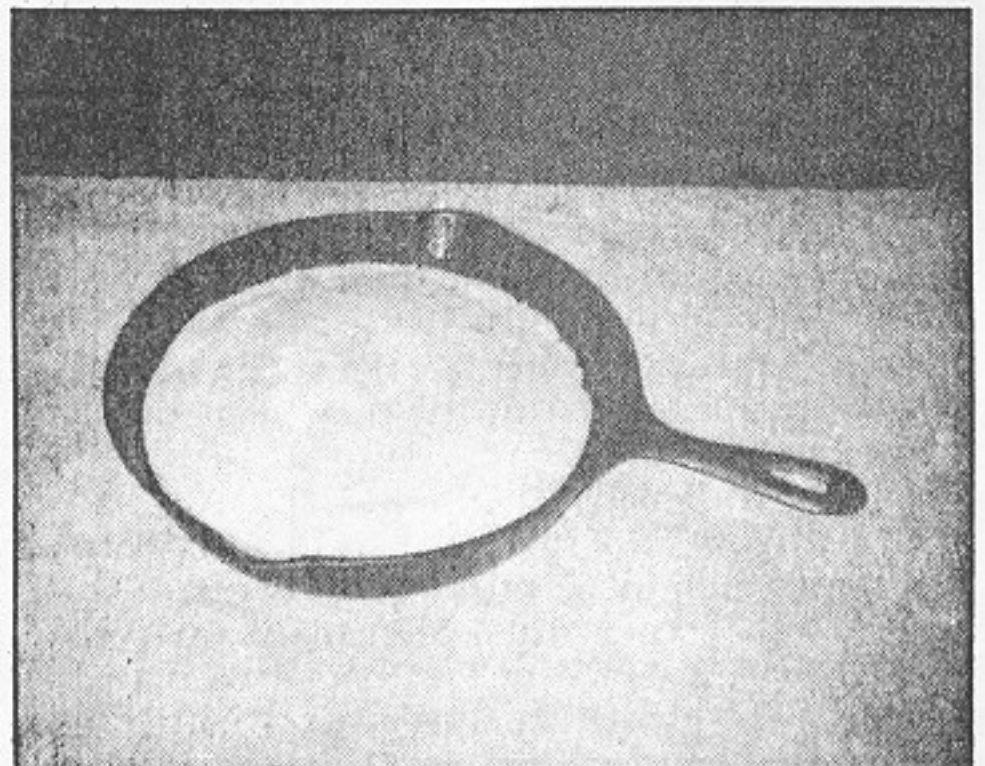
CORN MEAL MUSH LOAF

Instead of plain cornmeal mush you can make scrapple. That's simply the mush with meat scraps chopped up and mixed with the cornmeal during the cooking.

You can't beat the economy of cornmeal mush. At 6¢ a pound for cornmeal ground yourself, 2 cups or 10 ounces costs about 4¢. What you get when it sets is just over 3-1/2 pounds of food for 2¢ a pound!

CORNBREAD

Now for cornbread. This is delicious and Southerners love it. It's among the simplest breads to make. It's baked in a greased or teflon-coated pan about two inches deep and 8 x 10 inches or round in an iron skillet.



CORN BREAD

It's cut into slabs and the slabs are then cut in half and spread with margarine. Cornbread doesn't

hold as firmly as wheat or rye breads so it needs half wheat flour for the gluten to keep it from being too crumbly. Cornbread doesn't lend itself to making sandwiches but it's bread all the same.

A favorite dish of mine since childhood is chunks of hot cornbread covered with pinto beans and the bean soup. Delicious!

To bake it you get together 2 cups of cornmeal, 1 cup of wheat flour, 2 tablespoons of bacon grease, cooking oil, melted margarine, etc., 2 teaspoons of salt, 1 egg, 3 teaspoons of baking powder and 1-1/2 cups of water.

To make a lighter loaf, substitute commercial white flour and milk and add another egg. This may taste better to some, but I like the cruder kind just fine.

Mix the flours and add the grease or oil and mix some more. Then add the egg and salt and mix some more. Now add the water and mix until smooth.

Preheat your oven to 375 degrees F. and add the baking powder and mix again. Then pour the batch into the baking pan and put it in the oven. Bake it for 45 minutes.

When this is baked you'll have 1 pound 7 ounces of extremely rich bread for a total cost of just under 20¢. It's tasty, nutritious and very filling.

You can also make corn pancakes with this recipe. Use 2 cups of water so they'll spread and fry them in bacon grease, etc., in a hot skillet like regular pancakes. When the bubbles in the middle of the cakes stay open, it's time to turn them. A couple of minutes later they're done. These are heavier than flour pancakes. Spread them with margarine while hot and they taste great with salt and pepper or even syrup if you're into sweets.

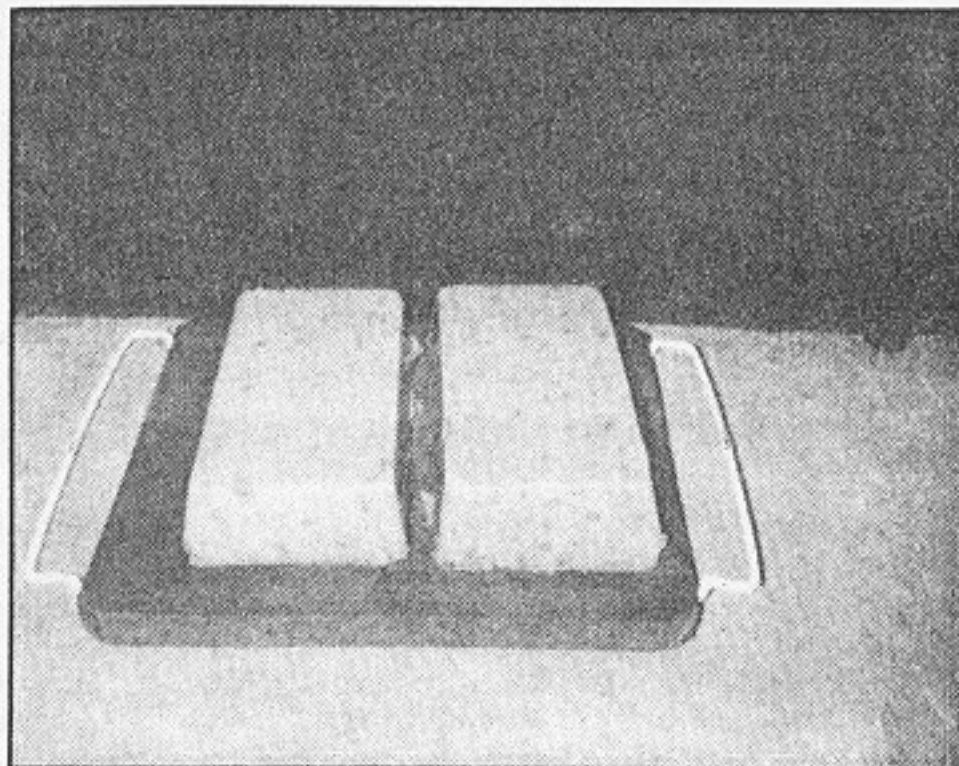
These are the corn dodgers Rooster Cogburn carried with him as his mainstay while tracking Ruffians.

CORN AND BEAN LOAF

While getting this article together I invented a staple food. I don't know what to call it, but it's a combination of corn and pinto beans.

First you cook the beans. Using your Crock-Pot you pour in 6 cups of water, 2 cups of pinto beans and 2 teaspoons of salt. Throw in some pepper, chili and whatever else pleases you. Turn the Crock-Pot on high and let it alone for 3 hours.

Then run 6 cups of cold water and stir in 2 cups of cornmeal. Pour this in on top of the beans. After an hour stir the cornmeal into the beans and stir well an hour later. Use a table knife to stir and go around the sides and bottom to knock loose any cornmeal that sticks. After one more hour give it another good stir to mix the beans well and then pour the contents out into two greased or teflon-coated bread baking



CORN - BEAN LOAF

pans. Next day the corn/beans will have set into two loaves which are sliced and fried or used any way you wish.

For this food, you've paid 40¢ for the beans if you bought them for \$10.00 for 25 pounds, which is the average bulk price. The corn costs about 4¢ and a few cents for salt, pepper or whatever and energy; say 50¢. It should weigh out at about 7 pounds. Using 1/2 pound as your main course, it makes 14 meals at 4¢ each.

Of course, you don't confine yourself to this. You use vegetables, eggs, bacon, gravy over it or whatever meat you have and just use the corn/bean loaf as the bulk of the meal. You could eat nothing else and do well but you'd soon get tired of it.

The point is, it's filling and nutritious. A study was made of the average Mexican's diet, mostly corn and beans. It was found that the beans provided all the needed protein and minerals and the corn the carbohydrates and vitamins. The two are almost a complete, complimentary nutritive package. And with side dishes, the average Mexican does have a balanced diet.

Perhaps you'd prefer your beans straight. A pound of dried pinto beans turns into 3 pounds of cooked beans. At 40¢ a pound, dried, that's a little over 13¢ for a pound of cooked beans.

Pinto beans are best cooked in a Crock-Pot as they take quite a while and no one cares with a Crock-Pot, but in a kettle they might be forgotten and burn.

Nothing is simpler to cook than beans. If you only want beans but little or no soup, put in 6 cups of water and 2 cups of beans, plus a couple teaspoons of salt, a teaspoon of pepper, chili powder and whatever seasoning suits you. Cook on high for three hours and if they mash easily they're done.

Otherwise cook for another hour. Since a Crock-Pot doesn't quite boil, you can't overcook them, so an hour or more doesn't matter.

If you want bean soup, use 8 cups of water.

I'd like you to make and try everything in this article. You'll find it's ever so easy and you'll be surprised at how much good-tasting, nutritious and filling food you can have for so little cost.

You'll not only learn how to cook but you'll realize that you and yours will never go hungry, as will so many who relate to food only as it is processed and prepared by others. You'll then wonder why anyone would be so stupid as to buy commercial "survival food" for \$thousands when you can do better for \$hundreds and learn while doing it.

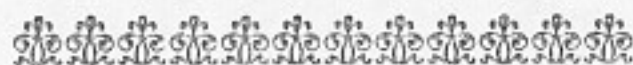
I lose patience with people who see such food as dull and unappetizing. Especially women. You go to a Mexican restaurant, or Chinese, or Italian, pay an arm and a leg for admittedly delicious meals. Yet you fail to see that they are all prepared with simple, inexpensive ingredients, most of which are

described in Survivor Vol. 1 or just about any good all-purpose cookbook.

Any woman who considers herself a good cook is fully capable of making any simple food taste good. If she can't, she'd better learn.

People who are so dependent-minded that they must pay others to prepare their food are in danger of losing everything. Don't you realize that that attitude causes the average family to spend about 30% of its income on food when they could eat better on about 5%?

Your family could eat better and put that 25% savings to building a family business which would make you valuable to your community. You could even afford a greenhouse alongside your home. Succeeding issues will teach you to grow lots of food in a small space and make more from a few hundred square feet of land than you can at most jobs. Also, it will insure your safety, as your neighbors will fight to protect their food supply, which could be you.

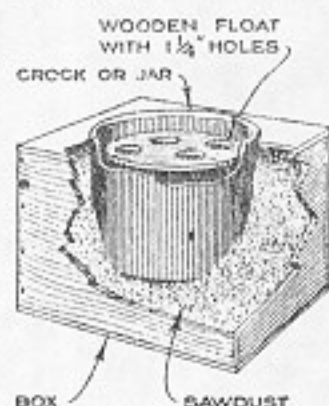


Nonfreezing Poultry Fountain

Popular Mechanics, 1925

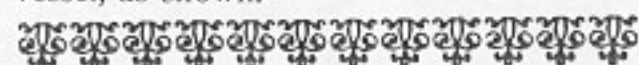
A drinking fountain for poultry that keeps the water cool in summer and prevents freezing in winter, and also prevents pollution of the water, is shown in the drawing.

A glass, or earthenware crock or jar is set into a wooden box, into the bottom of which several inches of sawdust have been placed; the space between the sides of the box and the vessel is similarly filled with sawdust. A wooden float, having a series of 1-in. holes drilled in it, is waterproofed with shellac and placed inside the water vessel, as shown.



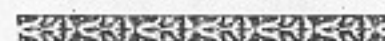
the drawing. A glass, or earthenware crock or jar is set into a wooden box, into the bottom of which several inches of sawdust have been placed; the space between the sides of the box and the vessel is similarly filled with sawdust.

A wooden float, having a series of 1-in. holes drilled in it, is waterproofed with shellac and placed inside the water vessel, as shown.



Revolving Ovens.—These ovens may be easily made by any tinman. They are not now manufactured for sale, which is to be regretted, on account of their obvious utility. When suspended in front of any ordinary fire by means of a bottle-jack or a common worsted string, the Revolving Oven will bake bread, cakes, pies, &c., in a much more equal and perfect manner than either a side oven or an American oven, without depriving the room of the heat and comfort of the fire. Before an ordinary fire, in any room in the house, it will bake a four-pound loaf in an hour and twenty minutes. It also bakes pastry remarkably well, and all the care it requires is merely to give it a look now and then to see that it keeps turning. The bottom of the oven* is made in the form of two saucers, the lower one of which is inverted, while the other stands on it in the ordinary position. A rim,

from 1 in. to 2 in. in height, is fixed round the edge of the upper saucer, but a little within it, and over this rim fits a cylinder with a top, slightly domed, which also resembles a saucer turned upside-down. In the centre of the top is a circular ventilator, through which steam, generated in baking, can escape, and the ventilator is covered by a domed plate, as large as the top of the oven. This acts as a radiator to reflect heat on the top of the oven, and is furnished with a knob, by which the cylinder that covers the article to be baked may be removed, in order to view the progress of the baking. Two strong wires project from the bottom on either side, terminating in loops or eyes for the reception of the hooks of a handle, by which the entire apparatus may be suspended in front of the fire.



Stone Jug Makes Effective Bumble-bee Trap

BUMBLE-BEES and hornets often make their home near farm homes, where they enjoy life much to the annoyance of farm folk and live stock. A very simple jug-trap can be rigged up in a few minutes to catch these unwelcome visitors. A piece of newspaper is rolled into a tube to fit the mouth of a gallon stone jug, and a few drops of honey or syrup are placed within the tube. More honey is deposited in the jug, and the paper tube is inserted as shown. Bumble-bees will be immediately attracted by the sweet bait and enter the tube. Once they get through the tube into the jug, they will be unable to find their way out, and can be disposed of as desired. A couple of hours should be sufficient to trap an ordinary swarm of bumble-bees.—G. E. Hendrickson.



Pastilles for Burning.

Cascarilla bark, eight drachms; gum benzoin, four drachms; yellow sanders, two drachms; styrax, two drachms; olibanum, two drachms; charcoal, six ounces; nitre, one drachm and a half; mucilage of tragacanth, sufficient quantity. Reduce the substances to a powder, and form into a paste with the mucilage, and divide into small cones; then put them into an oven used quite dry.

THE PERFECT 3.3 CENT BREAKFAST

By Kurt Saxon

A while back some Mormons visited me and told me of a friend who had been suckered into paying \$12,000 for a year's supply of "Survival Food" for his family of five. The seller had given him a break by not charging anything for the baby.

The only good thing one can say about most commercial survival foods is that they won't taste any worse in ten years than they do now. The worst that can be said for them, aside from their lack of nutrition from over processing, is that they cost an average of three times that of food from your local supermarket.

A year's supply of food would be nice and you should go for it. But be practical. Buy what you normally eat and like. Learn basic food processing so you can buy foods cheaply and in bulk.

Of course, we all use canned and processed food on a regular basis and they should always be bought by the case. You should figure how much of a certain product you will buy over the next year and buy it all at once by the case from your supermarket.

The economy is obvious. First, the supermarket manager will deduct at least 5%, since his people won't have to unpack it and put it on the shelves. Second, since food prices do nothing but rise, you will probably pay at least 25% more for the same products in a few months.

You can do even better by trading at the discount food stores like Sam's. Their prices average 10% above dealer's prices on most items.

Although food in cans, jars and dried packaged foods easily keep from three to five years if they are stored in a dry place, you can insure freshness by rotating. Say you bought ten cases of canned peas. Just mark the cases from 1 to 10. Use from case 1 and when that is emptied, buy another and label it 11. Then

start on case 2, buy another and label it 12 and so on. That way none of the food will ever be less than fresh.

When you incorporate grains into your diet you will see your food costs plummet. Buy a hand grain grinder and bake your own bread. You will save several dollars a month. It will also taste better and be more nourishing. You can even sell it to neighbors and even to local health food stores.

Grain grinders should be steel-burred, not stone. Stone grinders are a fraud. They are touted as causing less heat than steel. But hand grinding does not create the amount of heat objected to in the commercial milling of grains. So buy the much cheaper and more durable steel-burred grinder. Atlan sells the Corona Grain Mill for \$48.00 delivered in the continental United States (foreign please request additional shipping charges). It is the best for the price of any on the market and should last a lifetime.

The Survivor Vol 1 and Poor Man's James Bond Strikes Again video tape will give you an excellent grounding on the processing of inexpensive and nutritious foods. Through them you will learn that high food costs, and especially the need for commercial survival foods, are the results of ignorance. You may soon have to abandon the luxury of such ignorance.

But now to get to the main subject; the perfect 3.3 cent breakfast. This is just one example of a food which is easy to process, nourishing, energy and health giving and costs practically nothing.

It is simply four ounces of wheat, sprouted for 48 hours, cooked overnight in your thermos and put in your blender. This makes a large bowl of breakfast cereal which tastes wonderful and will give you more energy than you can imagine.

There are several steps to processing this food but it takes only a few minutes in all as you bustle about in your daily routine.

You probably already have most of

what you need but you should equip yourself with what you lack.

First, look up your local feed and seed store, even in a city, and call them. Ask if they have, or can order, 50 to 60 pounds of hard red winter wheat, untreated (treated seed is strictly for planting). There is no reason they should not be able to provide it.

It will cost between \$7.00 and \$8.00, depending on your location. Say it costs \$8.00 for 60 pounds or 13 cents per pound. You will use 4 ounce portions. That is 4 times 60 or 240 breakfasts or 3.3 cents for each breakfast.

One thing you will need is a Stanley Aladdin narrow-mouthed thermos bottle. These cost \$19.00 at Wal-Mart, are almost unbreakable and will last a lifetime. Don't be tempted to get a wide-mouthed thermos, if you mean to cook in it. It holds 3/4 cup less than you need. Also, the cap has a wider surface, which keeps it from holding the heat of the near boiling water needed for actual cooking.

Next you need two quart jars. Mayonnaise jars or similar will do. To cover them get some nylon window screen from the hardware store and cut two six inch by six inch squares. Put four ounces of wheat in each jar. Put the screens over the jars and hold them in place with large rubber bands. Fill one jar one-third with water and set it near the sink overnight.

Next morning pour out the soak water and drink it. It is vitamin-rich and a good morning tonic. Upend the jar in the sink to drain. After the first draining, flood the wheat about every four hours before bedtime and drain it. The idea is to keep the wheat moist.

At the last flooding the first day, just before bedtime, flood the second jar and let it set overnight like the first. Next day, drink the water and treat the second as the first, flooding both every four hours or so.

On the second evening the first jar of wheat will show sprouts protruding from the

ends of the grains. Now it is ready. It is part grain and part fresh vegetable. Its protein and vitamin content is higher and it is altogether a more complete food, rich and amazingly nutritious and, again, a complete meal for less than 4 cents.

Empty the sprouted grains into a two cup measure and put four more ounces of wheat in the jar, flood and set aside overnight as before. Now you have a perpetual routine taking up no real time and producing a fantastic amount of food for little cost.

With the sprouted grain in the two cup measure fill it with water to the two cup mark. Then pour it into a saucepan on the stove and add two more cups of water and a few shakes of salt to keep it from tasting flat. Heat it to a boil, which takes about five minutes.

You will need a funnel to pour the water and the grain into the thermos. Take a gallon plastic bottle; milk, bleach, vegetable oil, etc. and cut it in half. Use the top half for the funnel.

Fill your thermos with hot water to preheat it and then pour out just before filling with the grain. While the grain is still boiling, empty the pan into the funnel and so into the thermos. You will have to use a spoon to push part of the grain from the funnel into the thermos, as well as some of the grain from the pan. At any rate, do it quickly so you can cap the thermos to contain the heat.

Cap then shake the thermos and lay it on its side so its contents don't bunch up, and leave it overnight. Next morning, pour the contents into a blender and pour out part of the liquid into a cup. Drink the liquid as it is rich in vitamins.

With just enough liquid to cover the grain, turn on the blender at low. Then increase the speed until the grain is all ground to the consistency of oatmeal. You can add cinnamon or any other flavoring if you like but you will find it has a delicious

taste of its own.

You do not need much sweetener as the sprouting has created quite a bit of wheat sugar. You can add cream if you like, but I like mine plain. In fact, I just blend the wheat with all the liquid and drink it.

You will be surprised at the energy you feel even a few minutes after eating. Not only will it enable you to be more energetic and alert until lunch time but it will also be an excellent weight adjuster.

For instance, if you are overweight, that energy will make you more active and you will lose weight. If you are underweight, its carbohydrates will be burned up as energy and that same energy will activate and increase your musculature.

There is one possible drawback to this 3.3 cent breakfast. If you are active, no problem. But if you live a sedentary lifestyle and are sluggish, you may get the runs. Not chronic, just loose. However, this would only last a few days. After all, this is whole wheat, with all the bran. People have been eating roughly ground whole wheat for thousands of years. Up until about eighty years ago only the very rich ever ate white bread. Sluggish intestines were a rarity except among the wealthy.

Consequently, only the rich got colon cancer. Colon cancer is caused by the buildup of carcinogens on intestinal linings. The rough bran from whole wheat and coarsely ground corn kept the intestines of common folk free from any such buildup.

The same goes for oatmeal, which has recently been touted as the perfect bran food. It is a staple of the Scots and is high in protein. But what with the bran craze its price has risen much higher than its nutritive value.

So back to the wheat bran and its unsettling effects on the innards of sluggards. This is only temporary. Any radical, even beneficial, change in the diet will cause a reaction. The intestines are not harmed, any more than unused muscles are harmed after

a first day of horseback riding. The nether quarters doth protest but they soon get used to it. No need to overdo it to bowleggedness though.

So I am not suggesting this to be your whole breakfast permanently or that you make whole wheat your staple food. What I would suggest, however, is that you challenge yourself to make it your whole breakfast for two weeks.

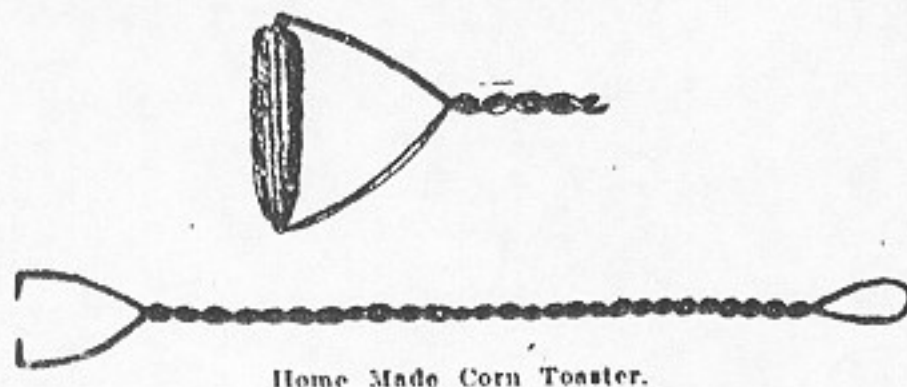
You will save money. You will experience fantastic energy. You will lose/gain weight. You will even get cleaned out and regular and will realize that you will never really need a laxative, even Metamucel, from then on if you eat only one serving each day. You will lower your risk of colon cancer. And you will never fear starvation as long as you have sense enough to buy whole grains in bulk.

Popular Mechanics Sept., 1902

BROILED CORN BETTER THAN BOILED.

The boys of 30 years ago knew a good thing when they used to go out and forage in a field of corn and roast the juicy ears over a fire. Of late years people have forgotten all about this, but in boiling sweet corn instead of roasting it, they are missing one of the best things in the eating line.

A prominent physician in Chicago, who has a fine summer home, hands us the following: "Corn broiled is as much more delicious than that which is boiled, as a roast of meat is superior to meat that is boiled. The inclosed sketch shows a broiler



Home Made Corn Toaster.

for corn on the cob which any boy can easily make by twisting a piece of galvanized wire. Bring the ends to a right angle, sharpen them to a point with a file, and there will be sufficient spring to hold the ear firmly while being roasted. About three minutes is sufficient over an ordinary cook stove with the lid removed. Make a few of these corn toasters and give a green corn roast party. It's great fun."

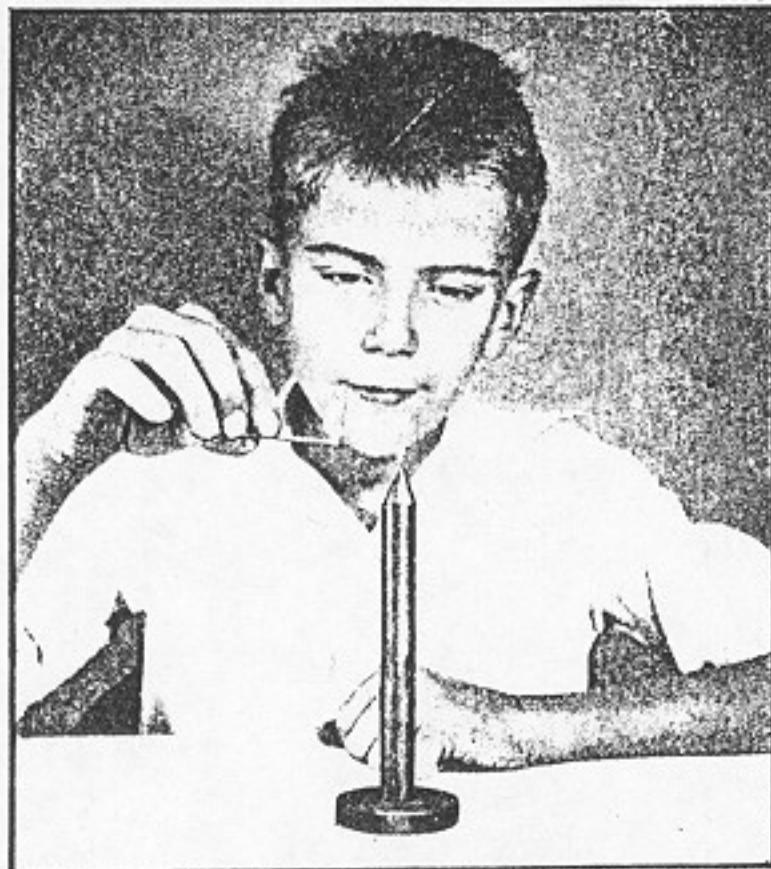
TRICK CHRISTMAS CANDLES SHOOT UP WHEN LIT

POPULAR SCIENCE MONTHLY Jan. 1933

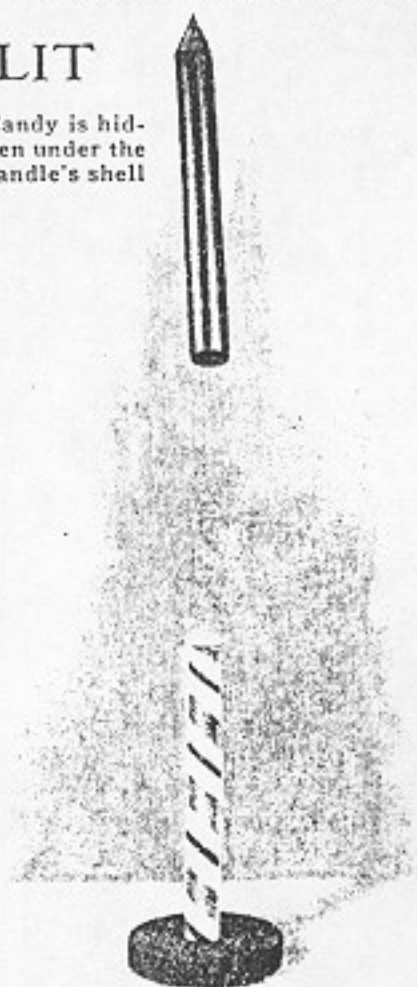
RED Christmas candles that will amaze and mystify the children can be prepared in such a way that when the wicks are lighted the outside, which is merely a shell, will shoot into the air and reveal a stick of candy. This is much more surprising and novel than an ordinary jack-in-the-box and is quite as safe.

Make the candles by rolling shiny red paper into a tube. Each tube fits over a stick of candy set in a hole in a 3 in. wooden disk, also enameled red. In the top of each tube, resting on the candy, is placed a coil spring tied up with a cord, and the ends of the cord project out of the top to form the wick. The cord is prepared in advance by dipping it into a hot, saturated solution of saltpeter with a little glue added. When the wick is lighted, it will burn down quickly and release the spring, and the candle shell will be shot high into the air.

A few candles prepared in this way will add to the gayety at any Christmas or New Year's party.—G. S. G.



Candy is hidden under the candle's shell



Wedging an Ax Handle to Hold Securely

Popular Science, March 1938

IF AN ax helve breaks—or a hatchet or hammer handle, for that matter—it is important to know how to wedge a new handle so that the head will stay on and so that the "hang" suits your personal preferences. In fact, even with a new ax it pays to buy the head and the helve separately and fit them to your own taste, provided you have had sufficient experience with an ax to know exactly what you prefer.

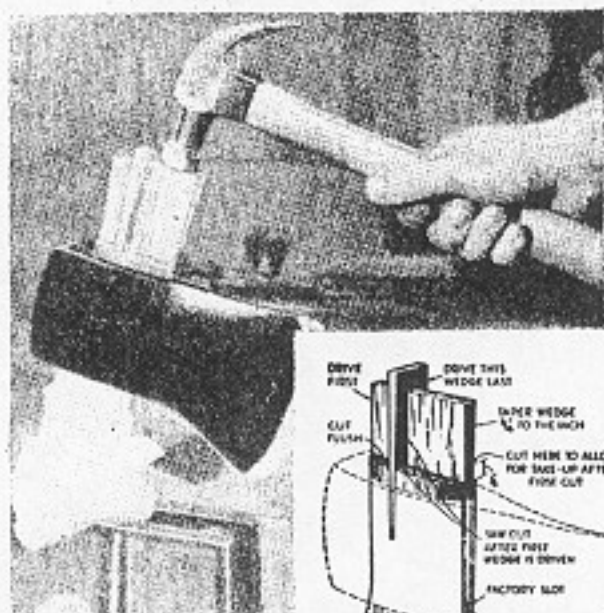
The helve must be well-seasoned, thoroughly dry, and so straight-grained that at least some of the grain may be

traced from one end to the other without interruption. For the wedges, spruce or other well-dried, tough wood will serve. Cut them with a taper of about 3/16 in. to the inch and with the starting edge thick enough to prevent its being pushed into the saw cut more than 1/4 in. by hand.

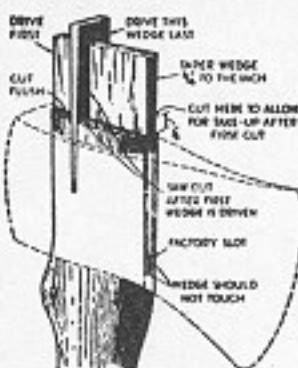
The helve is left 1/4 in. longer than the width of the head at the eye. Do not saw it off flush because the projection provides an extra clinching effect to the wedging.

With a maul or a piece of plank, drive the first or large wedge snugly in the usual position—that is, corresponding to the long axis of the helve. Then make a saw cut as shown in the diagram through the projecting part of the wedge and down into the helve, and start a thin wedge at right angles to the first wedge. The second wedge is a very important item as it prevents "rocking" and subsequent loosening of the head. After driving this second wedge with a hammer, cut it off at the end of the protruding helve, but be careful to leave the first wedge protruding about 1/4 in. from the helve to allow for future tightening after the ax head has been in use.

Always keep the helve dry, because alternate drying and wetting will loosen the head. As a further safeguard, I give the helve several coats of well-thinned paint, which is carefully worked into any crevices between the head and the helve. □

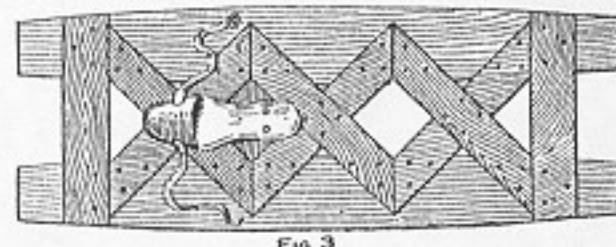


Ax heads stay on if wedged in this way



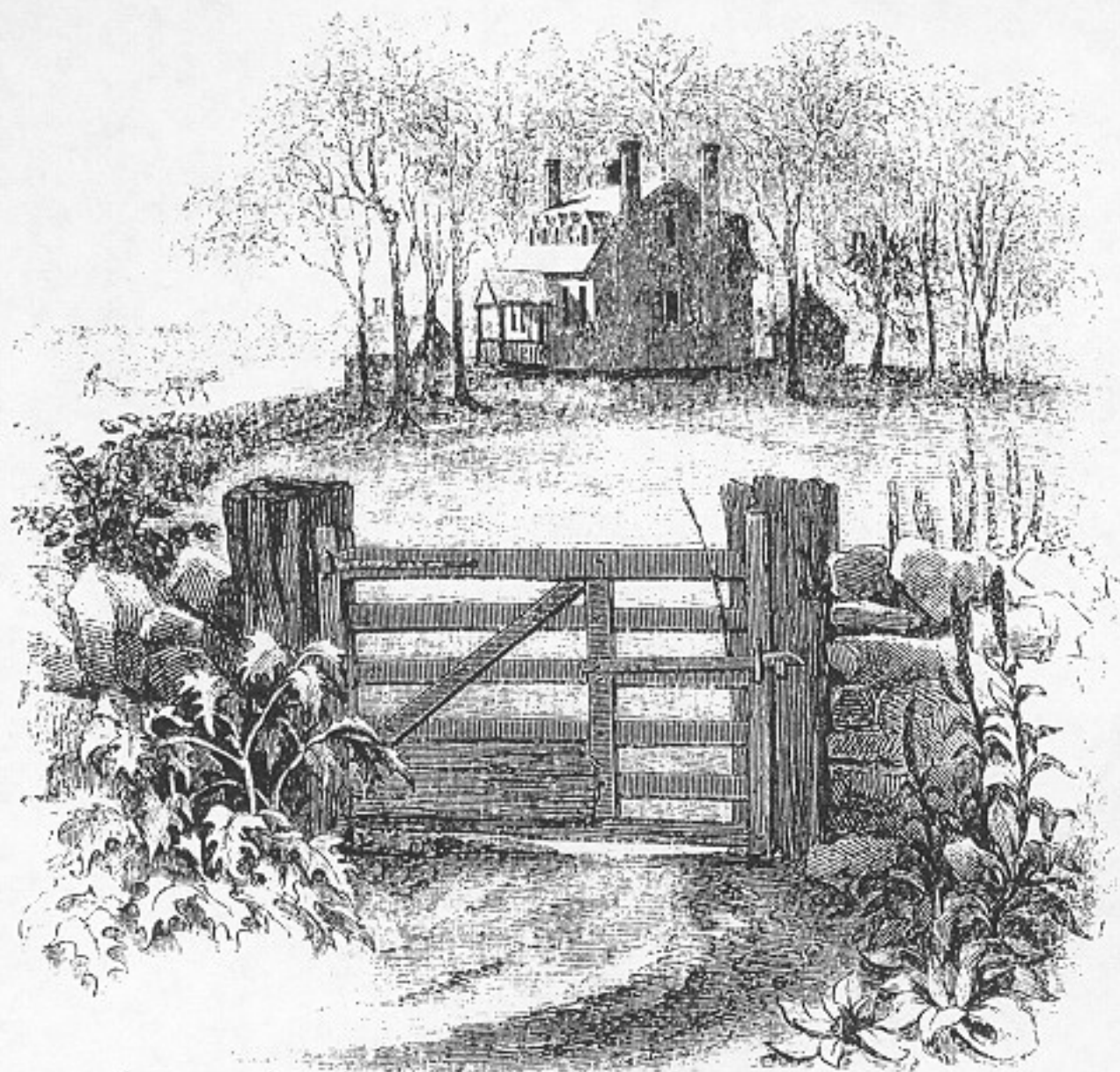
Homemade Snowshoes

Secure four light barrel staves and sandpaper the outside smooth. Take two old shoes that are extra large and cut off the tops and heels so as to leave only the toe covering fastened to the sole. Purchase two long book straps, cut them in two in the middle and fasten the ends on the toe covering, as shown in Fig. 1. The straps are used to attach the snowshoe to the regular shoe. When buckling up the straps be sure to leave them loose enough for the foot to work freely, Fig. 2. Fasten the barrel staves in pairs, leaving a space of 4 in. between them as shown in Fig. 3, with thin strips of wood. Nail the old



Made from Barrel Staves

shoe soles to crosspieces placed one-third of the way from one end as shown.—Contributed by David Brown, Kansas City, Mo.



HARPER'S NEW MONTHLY MAGAZINE. JAN. 1860

ROCKSTON.

D.H. STROTHER RURAL PICTURES.

A LETTER from the country—an invitation from my old friend, Colonel Manley. He wishes me to spend a month with him—six months—a year; in short, to take up my abode with him for life, if I could consent to so great a sacrifice.

Sacrifice! He must be poking fun at me. Does he imagine it is a sacrifice to leave the city with the opening of spring? to miss the dawdlings at the club-house, the yawnings at the opera, the dinings out, the evening parties? Faugh! Has he forgotten that I am no longer a boy? Well, never mind that. The old Hall is roomy, I know, but not so large as the heart of its owner. I will accept the invitation as freely as it was given. I will be with him too, sooner than he has bargained for. I will start to-morrow.

And I was as good as my word.

The next morning I was in the cars sweeping westward toward the blue mountains of Virginia, my mind occupied with mingling thoughts of the past and future. At thirty-five a man has accomplished half the journey of life, and begins to look back as frequently as he looks forward. I was thinking of myself—what else has a bachelor to think of? Besides, the country I was about to visit was the land of my birth—my boyhood's home—the theatre of youthful joys and follies. Under such circumstances it is quite natural that one's reflections should take an egotistical turn.

At the very outset of life I was left to my own

guidance with a fair education, a good constitution, and a moderate competence. Since then I have "followed the devices and desires of my own heart;" or, to use a more accurate expression, "of my own head." I gave myself to books and travel; coquetted with all the Muses; sometimes with a success that might have flattered another to more persevering effort. But it was contrary to my theory as well as my nature to devote myself to a *specialité*, so that I have been content to pass in society for a very accomplished person without attempting to scratch my autograph upon the rolls of Fame. If I have never followed any productive business, I have eschewed extravagance, so that my estate is unimpaired. If I have devoted myself at times to social life, I have carefully avoided excess, so that my constitution is sound, and, when not too closely occupied in literary pursuits, even robust. I have fixed my residence in a city, because one finds there ampler opportunity for the cultivation of elegant tastes, and, to be frank, a larger theatre for the display of accomplishment. I have shunned matrimony—why, it is nobody's business to know; yet one whose daily walk leads him through two or three miles of dry-goods and fancy stores may well be prudent.

I have sometimes flattered myself that I had mastered the art of living. Perhaps I have. When we feel satisfied that we have solved a problem, it possesses no further interest for us. This may account for the dull shadows of *ennui* that of late have so frequently darkened my sunshine—for the gradual drying up of the springs of enjoyment within and around me. Within

the last year, too, I have lost a front tooth, and the hair about my temples has begun to grizzle. Ah me! There may yet be something more in life than my experience has taught; and I have begun even to hope that there may be some flaw in my theory, for with the first mild breath of spring I have been yearning continually for the country, and dreaming of those pleasant days when the true and tender impulses of the heart withered not under the cold tyranny of Reason.

Five hours of railway travel brought us to the mountains, and on landing from the train I had my luggage transferred immediately to the coach that was to carry me to the village of Hard-scrabble—the seat of justice and chief town of my native county. The team was slow, the roads rough, and the driver a loutish negro, as spiritless as his horses. But as the distance was only eight miles, and I was the only passenger, I bore it all philosophically. About midway of our journey my Jehu turned the horses' heads into a fence corner, and, without leaving his box, commenced hallooing at a dilapidated barn that stood at a considerable distance from the road. Having used his voice to no purpose for some time, he concluded to get down and go over to the barn himself. After a while he came back, accompanied by a hatless companion of his own race, who had, apparently, been just roused from his siesta in a straw-rick, as his eyes looked swelled and his wool well dredged with chaff. Each of these worthies was loaded with a dozen ears of corn, which were presently deposited under the noses of the horses. The four-legged brutes commenced munching their bait with an appe-

tite, while the bipeds retired to a seat on the top rail of the next panel, lit their pipes, and discussed the affairs of the neighborhood at their leisure. This performance lasted for an hour by the watch, when we again got under way, and in the course of time hauled up in front of the village tavern and stage-office.

Although I was still five miles from the place of my destination, I did not regret to learn that this was the terminus of the stage line. I knew the road to Rockston when I was a boy, had often walked it, and could do it again. So leaving my baggage at the tavern, I started off, right glad of an opportunity to stretch my cramped legs.

As I trudged along many familiar scenes met my eye, just as I had known them in boyhood. At some points I was bewildered with changes: a forest cleared out, a thicket grown up, an alteration in the location of the road. Once I thought I had lost my way, but was soon reassured by the appearance of an unwhite-

washed, untidy, weather-boarded building which I recognized as the country store, at the cross roads, not more than a mile from Colonel Manley's. A couple of sleepy horses at the venerable rack, half a dozen coatless loafers on the dry-goods boxes at the door, indicated the character of the place without a sign-board.

Notwithstanding my vivacity at the outset I had begun to feel leg weary, and was glad of an apology to rest. A mingled odor of dry goods and groceries saluted my nose on entering; near the stove that of whisky and tobacco predominated. The civil clerk offered a seat, and then turned to wait on a rustic customer, whom he adroitly plied with inducements to purchase certain ten-cent calicoes of lively patterns.

"Fifteen yards?" says old Homespun, thoughtfully. "It takes a sight of truck to reach round wimmen nowadays."

"But think of the price! Only ten cents for such goods as this! Less than cost, I assure you."

"A dollar fifty," said Homespun, soliloquizing.

"What's a dollar fifty to spend on such a wife as you have got?"

"She's a middlin' solid chunk of a woman," replied the farmer; "gits stouter every year."

"Just look at these colors."

"It'll fade."

"If you stand as long as these colors you'll be a rich man, I'll warrant that."

"Wheat is ninety cents. I'll think of it."

"Better let me put it up for you now. Several of the neighbors want it. Mrs. Colonel Manley admired it very much—wants to get it for her daughter."

"Well," said Homespun, drawing out his leather purse and then putting it back, "I reckon I'll take jist a sample of it, to see if the old woman likes it, and then she can try if it'll wash."

The clerk tears off a sample, treats his cus-

tomers to a drink of whisky, throws his jug-laden saddle-bags across his horse, and wishes him a good evening.

If the daily exercise of tact, self-control under the most trying circumstances, universal politeness and good-humor, is calculated to improve the manners, surely a country store is the best school in the world for a young man.

Attracted by the click of the glasses, a fellow who had been dawdling about the door approached the counter. His physique resembled that of a dog that had been drowned for a week.

"Well, Squirms is lected," said he, addressing himself in a general way to the clerk, myself, and the bottle, with the apparent hope that one of us would respond. "We had hard work," he continued, "but the Dimocracy has carried every thing—Wigs and Know-nothin's hain't got no show now."

As there was no reply the swelled dog reluctantly walked away.

I turned to the clerk. "Your friend seems to take a deep interest in public affairs."

"He is excusable," replied the clerk, "since



COUNTRY STORE.

he has no business of his own to attend to. Last fall he was sold out by the sheriff; his wife and children are on the county. A week ago he was tried for trading with negroes, and only discharged for want of legal evidence. But he's one of our leading men in primary meetings, nominating conventions, etc. Perhaps you'll drink something, Sir?"

I thought I would relish a glass of toddy—my legs felt a little stiff. The pleasant gurgle of the liquid from the bottle caught the attentive

ear of the statesman, and he again approached.

"What's your idee of the chances for the next Presidency?"

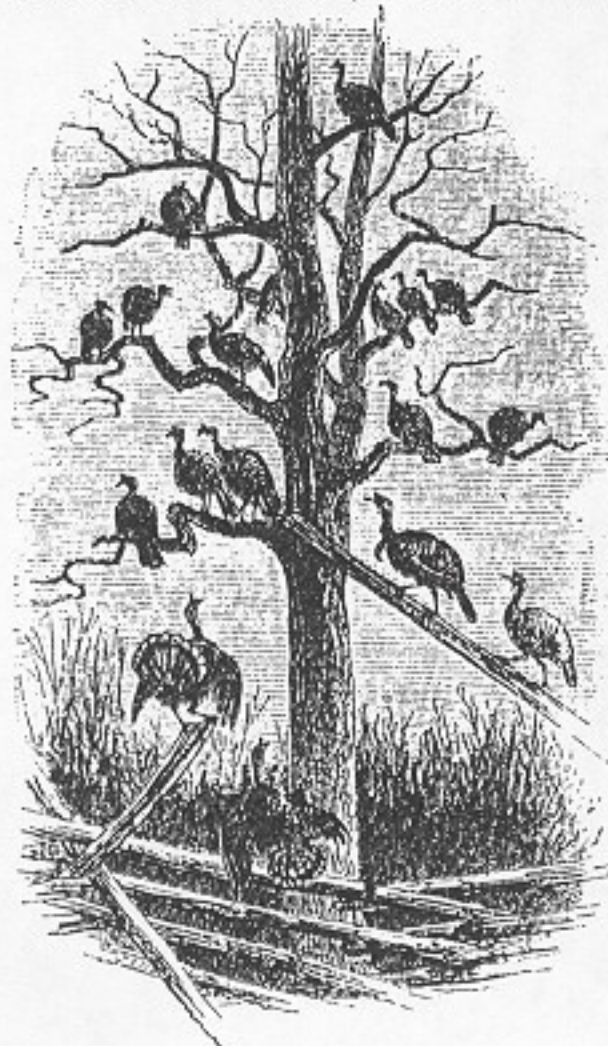
This, addressed directly to myself, was a poser. To acknowledge that I had no *idee* whatever on the subject might have lowered me in the esteem of the questioner. I therefore put my finger solemnly on the side of my nose, elevated my eyebrows, winked, and nodded toward the bottle, "Drink something?"

This solution of the momentous question appeared to be satisfactory in the highest degree. The face of the patriot burned with a lurid joy as he filled his tumbler to the brim. "Here's luck!" and in a twinkling the whisky was not. He made a sham motion toward the water pitcher, which resulted in nothing. Then leaning over as near as he could get to me he said, in an emphatic whisper, "The South is in danger—look out for squalls—you mind me."

I replied by a look of astonishment bordering on terror.

"They're a-scheming and a-conning to rob us of our property," he went on with increasing emphasis. "But never mind." (Here his voice grew familiar, and he made several efforts to put his arm around me, which movements I delicately eluded.) "But," he continued, smacking his lips and screwing his features into an expression of ineffable diplomacy, "never mind, wait 'till we git Cuby, then it'll be all right."

It was near sunset when I got to Rockston. The old house with its queer hipped roof and outside chimneys, drawn in sharp outline on the glowing west, presented a picture of unmistakable respectability which the most elaborate modern cottage or costly villa strives in vain to emulate. The very dilapidation visible



EVENING.

in its out-buildings and surroundings was more suggestive of easy, self-satisfied consequence than want of thrift or taste; while the sleek and elegant forms of the thorough-bred stock in the barn-yard, the shining faces of the negroes about the quarter, the tall grove that surrounded the dwelling, the huge pear-tree bending under its load of luscious winter fruitage—a flock of roosting turkeys—all characterized the abode of old-fashioned abundance and hospitality.

I stood leaning against the gate-post enjoying this scene until the red in the west gave place to the sheen of firelight through the windows of the old mansion. This reminded me that the evening air was frosty, and as the excitement of my walk had worn off I was chilled to the bone.

There was a warm hearth within, however, and a warmer welcome. The Colonel and his wife met me at the door, and there was a broad and genial sincerity in their greeting which took possession of the heart, as it were, by a *coup-de-main*—throwing into the shade the more pretentious and studied courtliness of cities.

I was warmed before I approached the fire—



THE POLITICIAN.

at home ere I was seated. The table stood ready set out in the middle of the room; but a sudden movement of the smiling mistress arrested the servant who was bringing in tea: as she bustled out with jingling keys I easily foresaw that some extra dishes were to be ordered. The wide hearth glowed with hickory coals, yet fresh logs must be heaped on, and fresh chips to expedite the blaze, until the very walls trembled with the roaring fire. For one moderate, middle-sized individual this seemed superlative.

There was comfort and supper enough for twenty. The Colonel was fond of politics and moral philosophy. He



BLOWING THE FIRE.

was stuffed full of talk, having his whole winter's reading undigested, and he evidently hailed me as an object whereon he might wreak himself. I, reckless of sanitary rules and diatetics, took double vengeance on the hot batter-cakes and stewed chicken. (Mrs. M. can, by a culinary process known to herself, make an old hen as tender as a spring pullet.)

"Things are getting into a devil of a condition," said the Colonel, throwing himself back in his chair with the air of a man who has uttered an incontrovertible truth.

"What's the matter?" replied I, buttering four more hot ones.

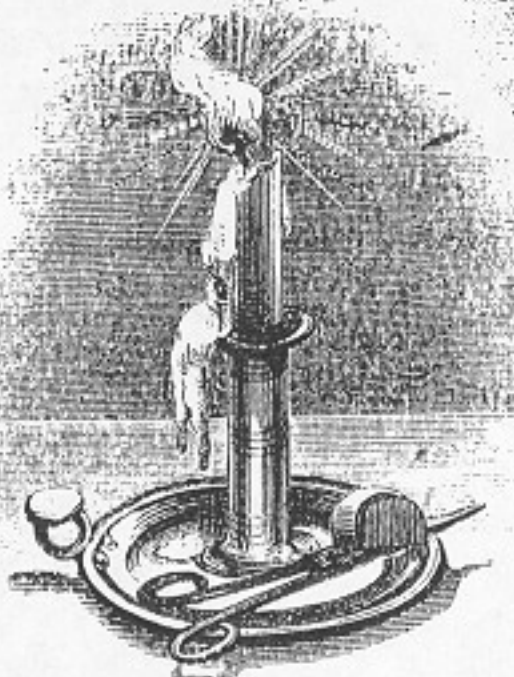
"What's the matter! why, look at the country, Sir; look at the government; look at every thing."

"Things look very well about here," I answered. "Another breast of chicken—thank you, madam."

He continued, "I begin to fear our whole system is based upon a fallacy. In the general mankind is—"

"I beg leave to differ with you," said I, "mankind is *not*."

The Colonel looked puzzled for



BED-TIME.

a moment; then smiled, and said,

"I perceive you don't take much interest in politics."

I detected a shade of disappointment in his face as he said it.

"Pardon my levity, Colonel; but good cheer and the sight of old friends have gladdened my heart, and have incapacitated me from taking a grave view of affairs, either public or private. I must acknowledge, however, that of late years I have troubled myself very little about the government, believing that, in ordinary times, that citizen best serves the State who manages his own business best."

"Suppose George Washington had held such an opinion?"

"Ah! those were not ordinary times. When the Union cracks open, for example, and another Quintus Curtius is wanted, just let them call on me."

"That savors too much of ambition. The true patriot serves his country, oftentimes, even without the hope of glory or reward."

"Then I certainly met one back here at the cross-roads this evening—a fellow that looked like a boiled dog."

The Colonel reddened. "That worthless



THE PET.

scoundrel is the person we suspect of stealing Mrs. Manley's turkeys last Christmas."

"I suspect," said the good dame, "that Mr. Berkeley is tired after his long journey, and would like to go to bed."

The suggestion chimed in with my feelings precisely; and ere long

I had snuffed out my tallow dip and rolled into a high feather-bed with a delicious sense of weariness that I had not enjoyed for years.

"Dreams, call in the morning. Days of my youth, I will remember you to-morrow. For the present, good-night!"

My awakening was greeted with pleasing and familiar sights and sounds. The sun, like a hidden archer, was shooting his level beams from behind a pointed hill, glancing through the leafless tree-tops; reddening the distant summits, while the shadowed meadows were lightly veiled with a blue transparent mist. The whole plantation was astir, and I lost no time in getting out to see the fun. The turkeys had come down from their roost, while two rival cocks were strutting and gobbling—emulous in puffing and absurdity—reminding one for all the world of a couple of oratorical demagogues before the people.

As in company with some thirty or forty feathered bipeds I stood admiring this droll exhibition, I observed a negroling, accompanied by a brace of dogs, edging up toward me, his countenance evidencing a mixture of shyness and curiosity. By a sudden movement I cornered him between the porch and the house. Finding there was no escape, he stood for a moment in amazed uncertainty, then mustered pluck to inquire his fate.

"You gwine to cut my head off, Sir?"

I assured him that I had no such intention at this time. His face shone with satisfaction; and feeling secure of his own safety, he undertook to inform me of the worthy character of his companions.

"Dese is good dogs, Sir; dey don't suck aigs."

I was much gratified to hear it, but intimated that one of them had a bad countenance.

"Dat's Caesar, Sir. He did used to suck 'em, but dey done burnt his mouf wid a hot aig, and he don't do it no more."

Upon this I promised that the dogs might go unharmed as long as they behaved themselves, and the party then ran away shouting and yelping for very joy. The delicious freshness of the air induced me to continue my walk toward a large pasture field beyond the barn, where, gathered upon a rocky knoll, I observed a fine flock of ewes with their new-born lambs. Although no sentimentalist, I could not but pause to admire this gentle family. To the political economist a sight of the South Downs, in their unshorn comeliness, might have suggested good mutton and woolen factories. To the speculative philanthropist, the model of a community opposed to war—of a society based on innocence and love.

Alas for seraphic philanthropy, and the pretty gamboling lambkins—to a certainty you will all be shorn and roasted in the end!

I found more entertainment in considering the subject artistically—in the picturesque beauty of the attitudes and groupings; or physiognomically—in the varied expressions of the sheepish faces, ranging from poetic meekness and in-



MORNING.

nocence, through every intermediate phase, to the most ludicrous silliness. It is a vulgar error to suppose that one sheep's head is like another, yet it is an error into which many of our celebrated animal painters have fallen. In expending their skill upon the anatomy, drawing attitudes, the peculiar texture of the covering of hair, wool, or feathers, they have done much that is essential; but not all, if they have in so doing neglected the individual and characteristic expression of the animal's face. To the accurate observer there is nothing mysterious in the readiness with which a lamb recognizes its mother; nor does he find it difficult to believe that the Laplander, who has more rein-deer than he can count, will yet immediately detect the absence of one familiar face from the herd. Give a man a microscope, and a motive, and I believe he could seat himself by an ant-hill, and in the course of time make the personal acquaintance of every individual in the community.

A sudden movement among my sheep caused me to turn; and the world thereby lost a lecture on bestial physiognomies.

At my elbow stood the cause of the disturbance—the negro whelp and his dogs. I felt vexed at the interruption, and ordered him off. Instead of obeying, he began another eulogy on the character of his playmates, earnestly setting forth their spotless innocence in regard to sheep-killing, and extolling their prowess against cats, pigs, and ground-squirrels. When he had talked himself into a hard knot, I repeated the order with a menacing look and gesture.

"Dere's a sick lamb," quoth he, "what's gwine to die."

True enough, there stood a ewe with rueful face and distended udders beside its helpless weakling. It was curious to observe the simple arts of the poor creature to attract the lamb's attention to its natural food. In vain she bleated and gently pushed it with her foot. Nature's first instinct was wanting or dormant, and the little one refused to take hold. I called the attention of one of the farm hands to her case. He immediately took her, relieved her swelled teats of their superabundance; and then opening the lamb's mouth with his finger, filled it with the fragrant milk. The little creature swallowed again and again, and at length revived sufficiently to make a successful effort to help himself. In a few minutes he got upon his legs, and trotted after his joyful mother to rejoin the flock.

The jingling of a bell at the mansion announced breakfast, and a cheerful hour in the frosty air had made the sound a most welcome one.

After breakfast the Colonel formally introduced me to Bias, his swarthy seneschal, and put the house and estate at my disposal. There was a saddle horse for my especial service; a buggy for a drive; a fowling-piece to shoot black-birds (no other game being in season); and, finally, the library, with nothing in it of a later date than Scott's novels, if we except agricultural periodicals and newspapers.



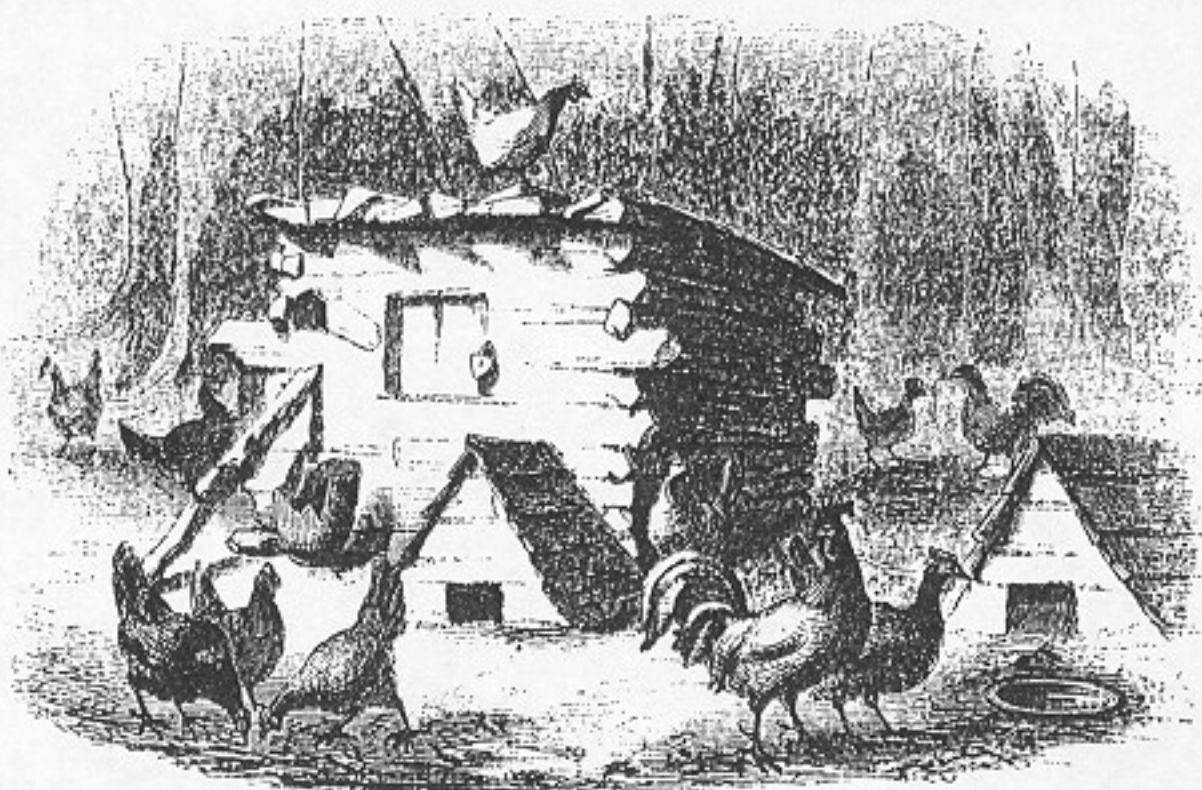
BIAS.

Then for the programme of the day. The Colonel was a man of business. Although he kept an overseer he was in person chief manager of the estate. He took breakfast at seven, dined at one, supped at seven P.M., and went to bed at eight, except when he had company. In addition to his private affairs, he held public offices of trust and dignity that occupied his time. He was a Justice of the Peace and President of the Agricultural Society. To-day he had business on the farm and in town. They were planting corn, and it was law day. Would I ride with him? "Remember at Rockston you are in Liberty Hall?"

I respectfully declined the ride, the buggy, the gun, the library. In short, I determined to pass

the day according to a fancy of my own. It should be a day of strolling idleness among scenes that had been familiar in boyhood.

I set out, therefore, with a sketch-book in one pocket and a volume of Thomson's "Seasons" in the other, useful to balance the skirts of my coat. Having fetched a compass, avoiding the barn-yard, I crossed an open field, and entered a romantic forest much broken with ledges of limestone rock and briery thickets. Here, in a secluded nook, I seated myself, and gave memory the reins. Vaguely and reluctantly at first the shadows came forth from the great cemetery of the Past, until called and quickened by some familiar sight or sound. The form and color of the ferns and lichens about the rocks—the tapping of the woodpecker on the hollow trunk—the bark of the squirrel—the very smell of the dried leaves, had its associations. Soon by-gone scenes, time-dimmed and distant, were seen life-like and near, while faces of the dead and forgotten crowded around me warm with the smiles of by-gone love and friendship.



THE HEN-HOUSE.

The imp fled through the bushes like a rabbit with the dogs after him. I followed, shouting, threatening, and pelting them with stones, until they disappeared over the brow of a hill in the direction of the house.

Resuming my walk, I passed through the wood, and on its further border paused to note a group of hen-houses prettily located among the trees. I was the more pleased to perceive that the tenants of these rustic dwellings were of the old-fashioned breeds; that the lord of the hamlet had the chivalric bearing and elegant form of the game cock. How his crimson coronet and brilliant plumage recalled the joy and pride of my boyhood! What dauntless courage in his clear eye! what proud defiance in his clarion notes! yet with what knightly courtesy

"He chucketh when he hathe a corn y-found!"

The very type of the ancient gentleman whose decadence poets profess to lament, yet which all join to expedite. How much the displacing of this noble bird from his rightful and accustomed walks, and his substitution by that ungainly mass of cowardice, greediness, and feathers, the Shanghai, may have had to do with the deterioration of society, I will not venture to suppose. But when we remember the men of light and leading who once trod the walks of our Republic, and then consider those who occupy their places, one may be excused for looking into the poultry-yard and speculating on the different breeds of chickens.

While I was pondering on these things a negro woman, somewhat advanced in years, approached, and saluting me politely went on to look into the hen-houses, opening and shutting the doors and moving the water-pans in a manner that convinced me she had come rather upon an errand of curiosity than of business. Indeed I was not sure but that the sight of a stranger loitering about the chicken-yard might have excited some uneasiness in her mind, and, to dispel any possible suspicion, I called her to me and questioned her in regard to the modes of raising fowls, the proprietor of the great house that stood near, the estate she belonged to, etc., upon all which subjects her answers were respectful but curt. But when I told her my

name her quiet manner was changed instantly to one of excited and voluble pleasure.

"Why, Mass Berkeley, is this you? Laus a-mercy, Sir, I've Harry's wife—you 'members Harry—I must run and tell him."

And she did run. It was now my turn to be surprised. "How does this woman know me? Who is Harry? Whence this flattering welcome? She possibly mistakes me for another, yet she seems familiar with my name!"

While I stood thus puzzling my brain the good woman returned with her man, a stout negro with bald forehead and grizzled hair, apparently about sixty years of age. As I looked up he exclaimed,

"Lord be praised, Mass Berkeley. It is you,



THE OVERSEER.

"Gillian is dead, God rest her bier;
How I loved her twenty years syne!
Marion is married—while I sit here
Alone and merry."

"Merry!"—no, not merry, Mr. Thackeray. Confound those worthless dogs! And you here again, you imp of Satan! How dare you follow me around in this way?

"Master," cried the imp, stammering and trembling, "I seed you gwine to de woods, and I thought you gwine to hunt ground-squirrels, and I fotch de dogs."

"Away with you, pestiferous varlet!" cried I, whipping out my penknife and rushing at him. "I'll cut you into forty thousand giblets!"



THE GRANDCHILD.

sure enough. I didn't believe Melindy." And the good old soul saluted me as if he were a Roman bowing before a patron saint. Ah! that face shining with gratitude—that voice husky with emotion—made all clear in a moment. I remembered Harry and the circumstances of our

first acquaintance.

"How long has it been, Harry?"

"Four-and-twenty years, Master. I have taken account of it year by year."

"Four-and-twenty years! Can it be possible?"

So we went to their cabin, where presently a dozen or more children and grandchildren dropped in by twos and threes. These, as they were successively presented, made obeisance and retreated into nooks and corners, where, with stretched eyes and hanging lips, they stared at me reverentially, as though I were a tutelary divinity.

"Twenty-four years ago," I repeated, mentally. "Since that time how many loves have grown cold—how many friendships perished—how many pearls cast before swine—how many hundreds of dollars worse than wasted—yet in the ruder soil of this faithful heart my childish hand had planted the seed of gratitude, which, like Jack the Giant-killer's bean, grew and grew and grew, until the plant seemed out of all proportion to the root from whence it sprung, or to the earth that sustained it."

On a cold drizzling morning, twenty-four years ago last Christmas, I was making my way through the village of Hardscrabble with a light heart and a Christmas quarter in my pocket, mentally rejoicing in the number of cakes, marbles, and fire-crackers that would presently come into my possession. As I passed the county jail I was arrested by the sound of a melancholy and not unmusical voice singing a Methodist hymn; and on looking up I saw the face of a negro man at the window peering wistfully through the heavy grating as he sung. When I stopped the music ceased, and the prisoner gave me a cheerful

greeting.

"Merry Christmas! young master."

"The same to you, uncle. You seem to be having a good time, though you are locked up."

"I sings, master, 'cause I'se so lonesome."

Now I thought of all the merry-makings that were going on in the neighborhood—the fiddling, dancing, fat turkeys, and good things that were in store for white and black; and then I looked at the cold gray stone walls, and the deep interior gloom behind the grim grated windows, and thought the poor soul might well feel lonesome.

"Well, uncle, it's best to keep up your spirits any way, and I'm sure you'll soon be out. But maybe you can play the fiddle, or can read, to pass away the time. I could get you a book, or borrow Nace Coleman's fiddle for you."

"Bless your good little heart, young master, I can't play on nothing, and have no larnin' of any kind. I can only sing two tunes I larned at camp-meeting, and whistle two or three jigs. The most I longs for is a pipe and some tobacco."

I was thrilled with a sudden joy, and hurrying as fast as I could walk to the store, I invested my quarter in a pipe and tobacco. Returning to the jail immediately, I hallooed to recall my new acquaintance to the window, from which he had retired.

"Here's your pipe and tobacco," said I, holding up the package.

"For me! young master?" exclaimed the negro, with grateful surprise. "Why, God bless the boy, has he spent his Christmas-money for the poor nigger?"

"I can get more if I want it," replied I, sturdily, although I was not so sure of it.

I tied the bundle to my little cane, and passed it up to the dusky hand that was stretched out to receive it, then hurried away in confusion to escape the thanks and blessings that were showered down from the prisoner's window.

For many days after I passed and repassed the jail on my way to and from school, never failing to exchange greetings with my grateful protégé, who always signaled my appearance by puffing a great cloud of smoke through the bars, to let me see that my present was well enjoyed. I do not remember that I ever inquired the cause of his imprisonment, or learned why he was released. Missing him from his accustomed place, I took it for granted that he had gone back to his people, and in a few weeks the whole affair had faded from my active memory.

Not so with Harry. In the following month of June I was agreeably surprised by a visit from him with a remembrance in the shape of a pair of young squirrels. So it continued, season after season, and year after year. Sometimes it was a dozen apples, a hatful of nuts, a superb water-melon, a brace of partridges—in short, any thing and every thing that his simplicity suggested, and that his humble means could command.

At length it seemed to me these grateful returns had so far exceeded the original obligation that, on receiving my accustomed present one day, I insisted on his acceptance of some remuneration. His look of wounded sensibility told me of my error before he spoke.

"Young master, I did not think you was a gwine to treat me so. You is gettin' proud now, since you growin' up to be sich a proper young man."

I protested against being thought proud, yielded my point, and peace was made.

The years of study and of travel, of calm thought and stirring adventure, that had passed since then had so nearly obliterated these little incidents from my memory that I recalled them with some difficulty; while in the monotonous and uneventful life of the negro "the time when Mass Berkeley spent his Christmas-money to get him pipe and tobacco" still loomed up as a prominent landmark.

Before taking leave, I was anxious to mark this visit by some especial compliment and gratification to my ancient friend. It was high noon. The morning's stroll had sharpened my appetite. I had remarked on the hearth a suspicious-looking heap of cinders, to which Madam Harry had occasionally paid some attention.

"Harry," said I, "I have not tasted ash-cake and buttermilk for twenty years."

Harry snickered outright. "Why, master, ef there is any thing Melinda can't be beat it—it's ash-cake."

The pleased alacrity with which the lunch was served showed that I had hit the nail on the head. I did not fail to point the compliment by doing the ash-cake justice, and then resumed my walk, feeling fresher in mind and body than I had done for many a day.

Through field and forest, glade and thicket, I rambled on dreamily, unconscious of the passage of time, until at length I was aroused from my reveries by the sound of a horse's hoofs rapidly approaching. I was in the midst of a dense wood, near a private road, which was apparently but little used. The sun was declining in the west. The dinner-hour was long past. My entertainers would be vexed. But I had no time to dwell on the subject, for the next moment a spirited black horse dashed by at full gallop.

The rider was an uncommonly pretty young girl—at least so she appeared to me, as I caught a glimpse of her face beneath the plumed riding-hat. She rode with the grace and confidence of an accomplished horsewoman; her figure, seen to advantage in the close-fitting habit, was strikingly elegant; while a profusion of flaxen ringlets fell upon her shoulders and floated in the breeze.

This much I noted during the fifteen seconds she was in sight. The adventure was decidedly emotional, driving the sheep and all the other rural pictures out of my head. Oh! the vanity of getting wisdom, and the absurdity of consorting with owl Professors, if a man of my age is liable to be thus flustered at the sight of a country lass riding through the woods! She rides well—but let her go; she looks as if she were fully able to take care of herself. What is she to me? By-the-way, what an admirable sight a fine horse is, especially when excited and moving rapidly! Ah! here comes a woodman with an axe on his shoulder; and, as I live, another old acquaintance!

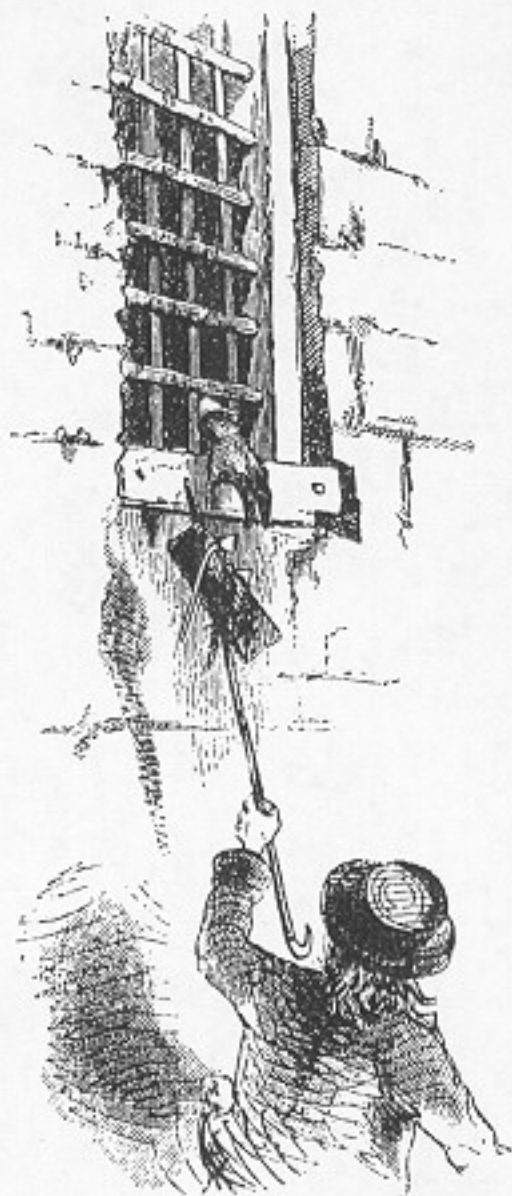
"Hallo, Gabriel!"

"Sarv'nt, master!" said Gabriel, lifting his hat.

"Gabriel, what young lady was that who rode by just now?"

"Didn't see her, Sir. I jest been choppin' a little wood up here on de hill, and as it's nigh sundown I'm a gwine home to supper."

"Look at me, Gabriel: do you know who I am?"



THE PRISONER.

Gabriel did as he was ordered; but presently shook his head. "Please God, master, your face looks kind'a like somebody I knowed, but I can't 'member 'zactly wha' to place you."

"Don't you remember Robert Berkeley?"

"Don't tell me dis is Mass Robert Berkeley!" cried Gabriel, with a grin.

"The very same," I answered, while fumbling in my pocket for a quarter.

"Why, master, I never would have knowed you; you begins to look middlin' old."

"The devil I do!" I replied, withdrawing my hand and buttoning up my pocket.

As I started up the road I turned and hallooed, "Gabriel, do you remember the time Colonel Manley caught you in his hen-house?"

"Go 'long, Mass Robert! Who'd a thought you 'member dem foolish stories."

"Look middlin' old," do I? you anointed old chicken thief!"

As the sun was nearing the horizon I quickened my pace, and in the course of half an hour the chimneys of Rockston were visible, gilded by the rays of the setting sun.



MISCHIEF.

Passing by the quarter I was startled by an outbreak of unearthly yells, accompanied by vociferous scolding, sounding thwacks, barking of dogs, and loud guffaws of Ethiopian laughter; a mingled din, that startled the turkeys on their roost. A single glance sufficed to elucidate the whole matter. A half-drowned kitten escaping from the wash-tub; a stout matron, with the whelp's head under her arm, administering the condign with a heavy hand; attendant negroes and dogs laughing and barking their respective sentiments of approbation or disapproval of the proceeding.

One deeply versed in the mysteries of the human heart says that men, in spite of a Christian education, are very prone to feel a secret satisfaction in the misfortunes of others. I regret that candor obliges me to plead guilty to the charge in this instance. I left my youthful friend and follower to the tender mercies of the oppressor, and made my way quietly to the mansion.

As I entered the Hall, with the consciousness that my day's tramp was concluded, a sense of fatigue took complete possession of me. The parlor-door stood ajar, the room was untenanted, and the twilight glow of a sunken hickory-fire diffused an air of comfort through it that was irresistible. I entered; and throwing myself upon an inviting lounge, was soon in full enjoyment of the most delightful of sentimental



THE CONDIGN.

luxuries—the dreams of evening twilight.

Pleasantly I reviewed the events of the day, with alternate smiles and soberness, following up their connections with the olden times; but most of all the fair lady of the forest haunted my thoughts with her weird beauty and dashing horsemanship. Now this unwonted freak of fancy puzzled me, for I had never been a recluse from society, and many a year had passed since the casual view of a pretty face could disturb the regularity of my pulse; whence, then, this vague and dreamy interest in a stranger, seen but for a moment, like a shooting star? Yet in that moment some rusted chord was struck, the sound whereof my dull ear has not caught; some gentle memory disturbed, not yet awakened quite to consciousness. Ah, faithless heart!—was it not Ellen Manley she was like? That sweet, laughter-loving face, those sunny curls, that form of grace. I have the secret now! Strange that I should have hesitated. Just so she looked when I rode beside her through these same groves, walked with her in these sunny lanes, worshiped her in this old Hall, and once—once only—on her red lips pressed the sweet seal of love:—ye gods and goddesses, I believe it was on this very sofa!

But time, and books, and travel, and society; the world, with its reasonings, and theories, and babblings! Has such trash then so nearly obliterated the golden dreams of my youth? Ah! sweet Ellen, had pride been less obdurate, or love more steadfast, a different life might have been yours and mine!

Ellen and myself were near the same age. When we were about sixteen we loved each other dearly, and were engaged. I sent her bouquets, wrote verses in her album, and gave her a gold ring with our names engraved on the inside; and she knitted me a purse of blue silk, and gave me one of her silken tresses tied with a blue ribbon. And when we got to this point, as a matter of course we quarreled. She returned my ring, which I pounded into little bits, and sent back to her; she threw them in the fire, and sent me a small paper of ashes, which I was given to understand was the remains of the ring. In a towering fury I took the flaxen tress with the blue love-knot her fairy hand had tied, and having frizzled it on a shovel, sent it to her recking. Back came the tattered leaf from her album, with my tender verses interlined with a ludicrous parody. Who ever had the last word in a quarrel with a woman? I gave it up, and got drunk. In a short time my guardian, fear-

ing that I was getting into bad habits, sent me away to college. Ellen went to Washington, caught a handsome beau, a captain in the army, who married her and took her to a post on the Western frontier. I have never seen her since. I hear that she is a happy wife and mother—may Heaven bless her!—and that her Captain is now a Colonel—may he soon become a General for her sake! She was not my first love, by half a dozen at least; nor my last, by a score. Yet now as I recall her she was the sweetest of them all—so beautiful, so enthusiastic, so artless, so sincere. Ah! could those days but come again, and I had the choosing, how gladly would I turn my back on the great world, with its gilded allurements, and seek the better part—a life-long companionship with a loving heart like hers! In dreams they say that Reason sleeps, while Fancy, ever watchful to escape her cruel mistress, slips her fetters, spreads her triumphant wings, and bears us, unresisting, where she lists.

Lights—voices! I started up in confusion. Good Heaven! is this a vision? My early love come back? Ellen Manley! A burst of laughter was the response my exclamation elicited. The Colonel stepped forward.

"You've had a good nap after your walk, Mr. Berkeley. This is my daughter Alice, the youngest-born of our house—our baby, as we still call her. She was an infant when you left us."

"Mr. Berkeley," exclaimed the old lady, "I fear you missed your dinner to-day. To be sure we had but little to tempt you: vegetables are so scarce at this season."

"Mrs. Manley," quoth the Colonel, "I'll



THE PROOF OF THE PUDDING, ETC.

guarantee that Bob Berkeley never sat down to a finer dinner than you had to-day. Such a ham, such a turkey, such a pudding!"

Mrs. Manley modestly confessed that the pudding was a success, and remarked that she had put away a piece of it for me.

"Cold pudding for supper!" cried the Colonel.

"By no means," replied the lady, with spirit. "I had it kept warm, and the turkey too. If the gentleman has missed his dinner, it will probably not be amiss at supper."

I must have appeared very silly meanwhile;

for instead of taking part in the conversation, I only rubbed my eyes and stared at the lovely vision.

The frolicsome curls were tucked up daintily, and the riding-habit exchanged for a simple gown of black silk. Dimpled smiles played amidst the roses in her cheeks as she spoke.

"I think I passed you in the wood this evening, Sir?"

"Ellen—" I stammered. "Pardon me—Miss—Miss—"

"Alice," she suggested, with a pretty blush.

Mrs. Manley spoke up:

"Mr. Berkeley forgets that his old flame, Ellen, is a fine motherly woman of thirty-five, with a son who expects to go to West Point next year."

This was the bucket of water that brought me to my senses. We laughed, and went in to supper. I then related the adventures of the day, not forgetting a description of my dinner, which caused a deal of merriment.

"Ah!" said the Colonel, "if you are fond of rambling over the country, either on foot or on horseback, this young lady will be your compan-

ion. It is her delight."

Mrs. Manley took this opportunity to express a hope that her daughter would lay aside certain wild, rustic ways she had acquired, and deport herself with a dignity and gravity befitting the occasion and company.

Bless the good lady! does she think I am a bugbear to frighten the girls? I'll take good care that Miss Alice shall not find my society a restraint.

We are to ride to-morrow morning.

Good-night, and pleasant dreams!

Secrets of Ventriloquism

Much has been written regarding this popular form of entertainment and it is our aim to simplify and not to confuse as in a majority of cases.

Ventriloquism is not the throwing of the voice as people are led to believe but merely the imitation of distant voices. Ventriloquism consists of two kinds, distant and near. The latter is used in connection with the wooden dummies that are so popular and that should be the starting point and the rest will come later and be far easier.

Secure one or two ventriloquial figures and you are prepared for work. Select your dialogue and practice the following:

Stand before a mirror and speak. While speaking, maintain a fixity of countenance and a rigidity of muscles and nerves about the face and lips, so that no visible movement can be noticed.

Begin by saying as distinctly as possible the vowel sounds — A-E-I-O-U.

Next close the mouth and rest the upper teeth on the inner part of the lower lip, but be sure that your expression is easy and natural. It isn't, make it so. Now, practice the vowel sounds again.

Some letters cannot be easily pronounced in ventriloquism. These are p, b, m. All words containing these letters will be hard to speak. When necessary to utter such a word you

should substitute some similar sounds, or turn your mouth away from the audience, so that you can move your lips without being seen. The former method, however, is preferable and should be generally adopted.

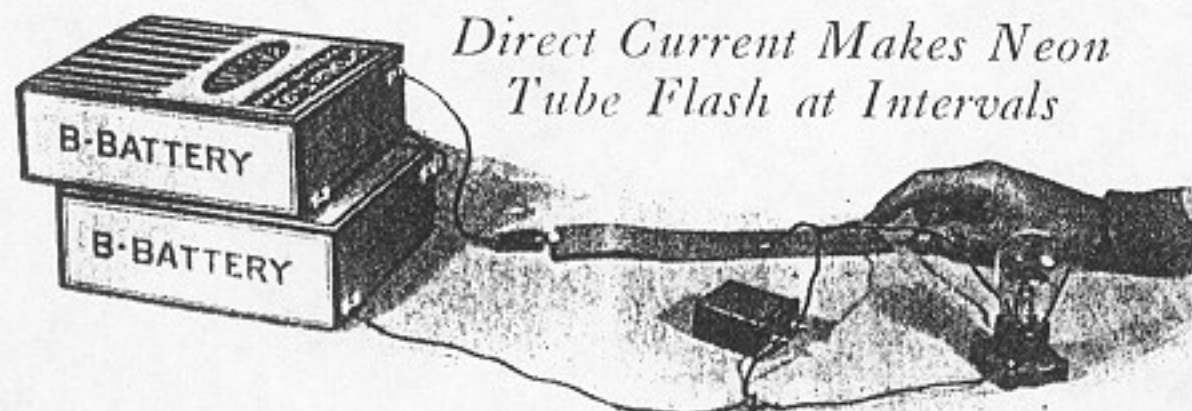


For instance: If you wish to pronounce a word with a "p" in it, substitute "f" or "k". For "piano" say "feano" or "keano." For "m" say "n" or "ng." For "molasses" say "nolasses." For "b" substitute "v" or "g." For "being" say "veing" or "geing."

Speak in the natural voice or the voice of some character you wish to impersonate. For instance, if you have an Irish figure, talk in the peculiar brogue known to the Irish people. Your success depends on how well you work your figures. The delusion is carried out by the movable jaw, hence there is no need of the sound of any distant voice. If you place a figure on either side of you, 12 feet distant and speak without moving the lips, the voice will apparently come from the figure whose jaw moves. However, you must use a little trickery and indicate to the audience by word or gesture, from which figure the voice will come.

Scientific Stunts

FOR THE HOME EXPERIMENTER



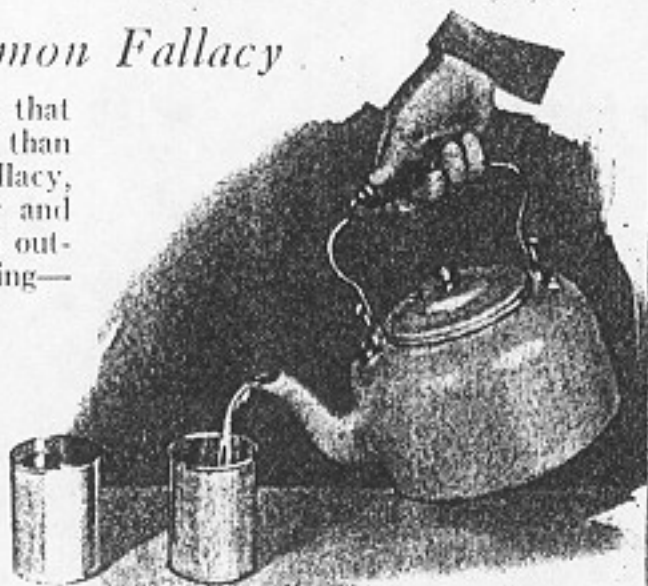
Direct Current Makes Neon Tube Flash at Intervals

CONNECT a neon tube and a condenser to a direct-current supply of about 100 volts, as shown, with a strip of moist newspaper to act as a resistance. The light will flash at in-

tervals, the current building up the charge in the condenser until it escapes as a flash. If the resistance is increased by moving the wire along the strip, flashes are less frequent.

Disproving a Common Fallacy

You probably have heard it said that hot water will freeze more quickly than cold. To disprove this common fallacy, simply fill one can with cold water and another with hot, and set them both outdoors—if the weather is below freezing—or in the cold compartment of a mechanical refrigerator. Contrary to the popular idea, the cold water will freeze first. This is the logical result, as the hot water naturally requires a longer time to lose its heat and reach the freezing point. The origin of the popular, erroneous idea is a mystery.



Mirror "Ghost Images"

PLACE a piece of metal on a mirror and allow it to stand for an hour. Then remove it and breathe on the mirror, and the object's outline will be seen on the glass. This is because the object has displaced the thin layer of gas held to all surfaces by absorption, changing the reaction to condensing moisture.

Test Shows Why Steam Pipes Hammer

BLOW a small bulb into the sealed end of a bent glass tube, partly fill the bulb with water, and place the tube in a tumbler of water as shown at the left. Heat the bulb until the water boils, and the tube will jerk violently up and down. The explanation is that when the steam from the bulb is condensed, water from the tumbler rushes up the tube, only to be met by more steam coming from the bulb. Similarly, the hammering of steam pipes is caused by steam entering cold pipes and condensing, causing a rush of water to replace it.



Measuring Magnifying Power

BY MEANS of a simple test, you can easily measure the magnification of a hand lens or microscope. With one eye, look through the lens or microscope at a sheet of ruled paper, and with the other eye at another piece of the same ruled paper held ten inches from the eye, as in the photograph. The number of spaces seen with the unaided eye that equal one space as seen under the lens is a measure of the magnifying power of the lens.



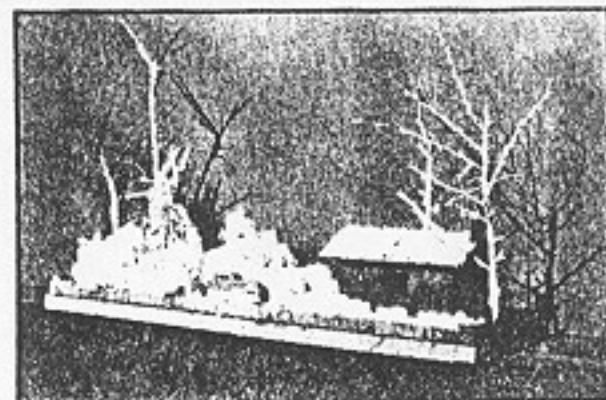
This easy test will tell you how much a lens magnifies



A QUICK GROWING DEPRESSION GARDEN

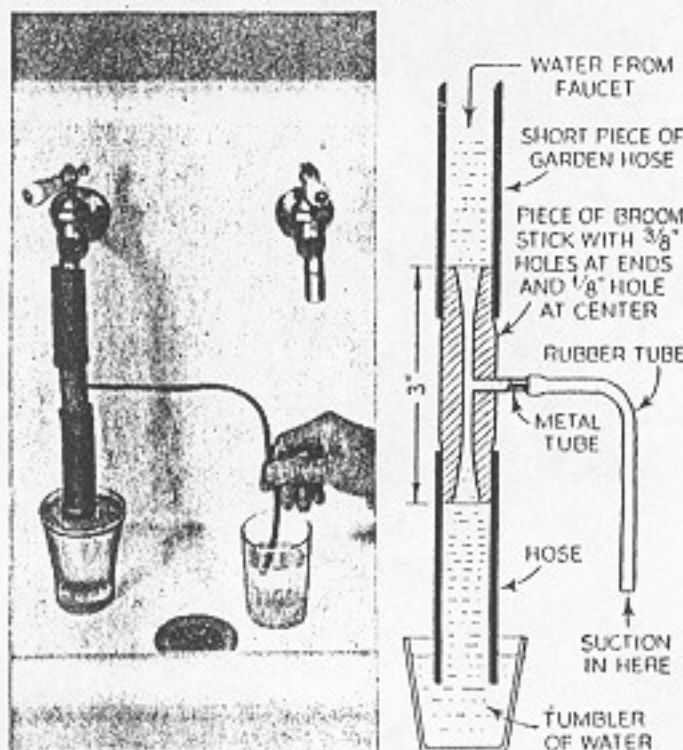
VARIOUS mixtures are used in making so-called "depression" gardens of the type illustrated, but I have found the following more effective than salt and bluing alone or other combinations: 4 tablespoons of salt and 2 tablespoons each of air-slaked lime, cornstarch, and bluing. Mix the three dry materials, then add the bluing and enough water to give a liquid mixture. This alone will "grow" into a beautiful snow effect, but a little fruit coloring can be added where desired.

The garden shown was made in a tin tray 1 ft. wide, 2 ft. long, and 1 in. deep. Plain ashes and a few small clinkers gave the hilly effect, and a few bare branches and cedar limbs were stuck into the ashes after being dipped into the solution. The house was built from scraps and the roof



This realistic snow scene was "grown" with salt, air-slaked lime, cornstarch, and bluing

covered liberally with the liquid. The fence was made from a strip of $\frac{1}{2}$ -in. hardware mesh. The little automobile is a toy.—CARL G. ERICH.



Making a Vacuum Pump

BY FOLLOWING the specifications on the drawing above, you can make a handy vacuum pump for your laboratory, and at the same time demonstrate a scientific paradox. When water flows through a constricted opening, you would expect a greater pressure at that point. However, if a hole enters from the side at the constricted point, air or water will be drawn in, instead of water coming out. This device will raise water over twenty feet.

Magic Spirit Hand

Popular Mechanics 1913

The magic hand made of wax is given to the audience for examination, also a board which is suspended by four pieces of common picture-frame wire. The hand is placed upon the board and answers, by rapping, any question asked by members of the audience. The hand and the board may be examined at any time and yet the rapping can be continued, though surrounded by the audience.

The Magic Wand, London, gives the secret of this spirit hand as follows: The hand is prepared by concealing in the wrist a few soft iron plates, the wrist being afterwards bound with black velvet as shown in Fig. 1. The board is hollow, the top being made of thin veneer (Fig. 2). A small magnet, A, is connected to a small flat pocket lamp battery, B. The board is suspended by four lengths of picture-frame wire one of which, E, is connected to the battery and another, D, to the magnet. The other wires, F

A WHIRLING toy that will give hours of amusement can be made in a few minutes. It consists of two 1-in. wooden balls, one painted red and the other green, and both drilled so that a cord can be run through them. The cord for one ball is 14 in. long and for the other, $15\frac{1}{2}$ in. The ends of the cord are passed through a cylinder of wood about $\frac{1}{2}$ in. in diameter and 2 or 3 in. long. The hole through the cylinder should be just large enough to take the two cords, but at one end the hole should be enlarged to a diameter of $\frac{1}{4}$ in. and sanded to a very smooth finish. The cords are passed through from this end and knotted at the other end as shown in the accompanying diagram.

Spin the ball on the shorter string in one direction very slowly. Then attempt to start the other ball whirling in the opposite direction. After a little practice, you will be able to make the balls rotate at high speed in opposite directions, forming a pleasing blur of color.—H.

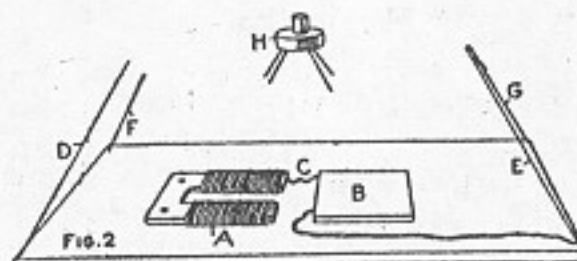


and G, are only holding wires. All the wires are fastened to a small ornamental switch, H, which is fitted with a connecting plug at the top. The plug can be taken out or put in as desired.

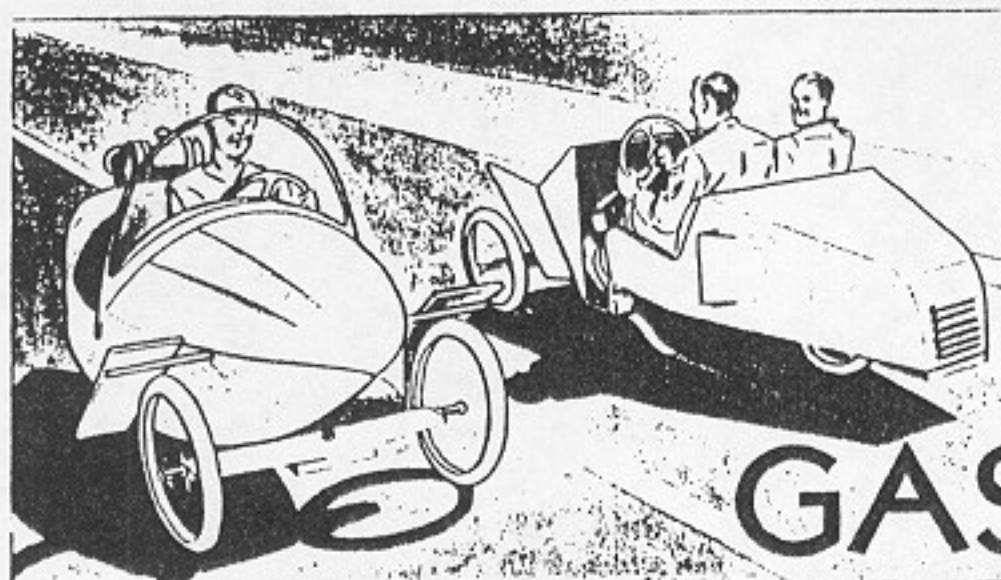
The top of the board must be made to open or slide off so that when the battery is exhausted a new one can be installed. Everything must be firmly fixed to the board and the hollow space

filled in with wax, which will make the board sound solid when tapped.

In presenting the trick, the performer gives the hand and board with wires and switch for examination, keeping the plug concealed in his right hand. When receiving the board back, the plug is secretly pushed into the switch, which is held in the right hand. The hand is then placed on the board over the magnet. When the performer wishes the hand to move he pushes the plug in, which turns on the current and causes the magnet to attract the iron in the wrist, and will, therefore, make the hand rap. The switch can be made similar to an ordinary push button so the rapping may be easily controlled without detection by the audience.



Wax Hand on Board and Electrical Connections



How would you like to make
a little car that can hit 35 mph
and gets 100 miles on a gallon?
Here she is!

by Doug Rolfe

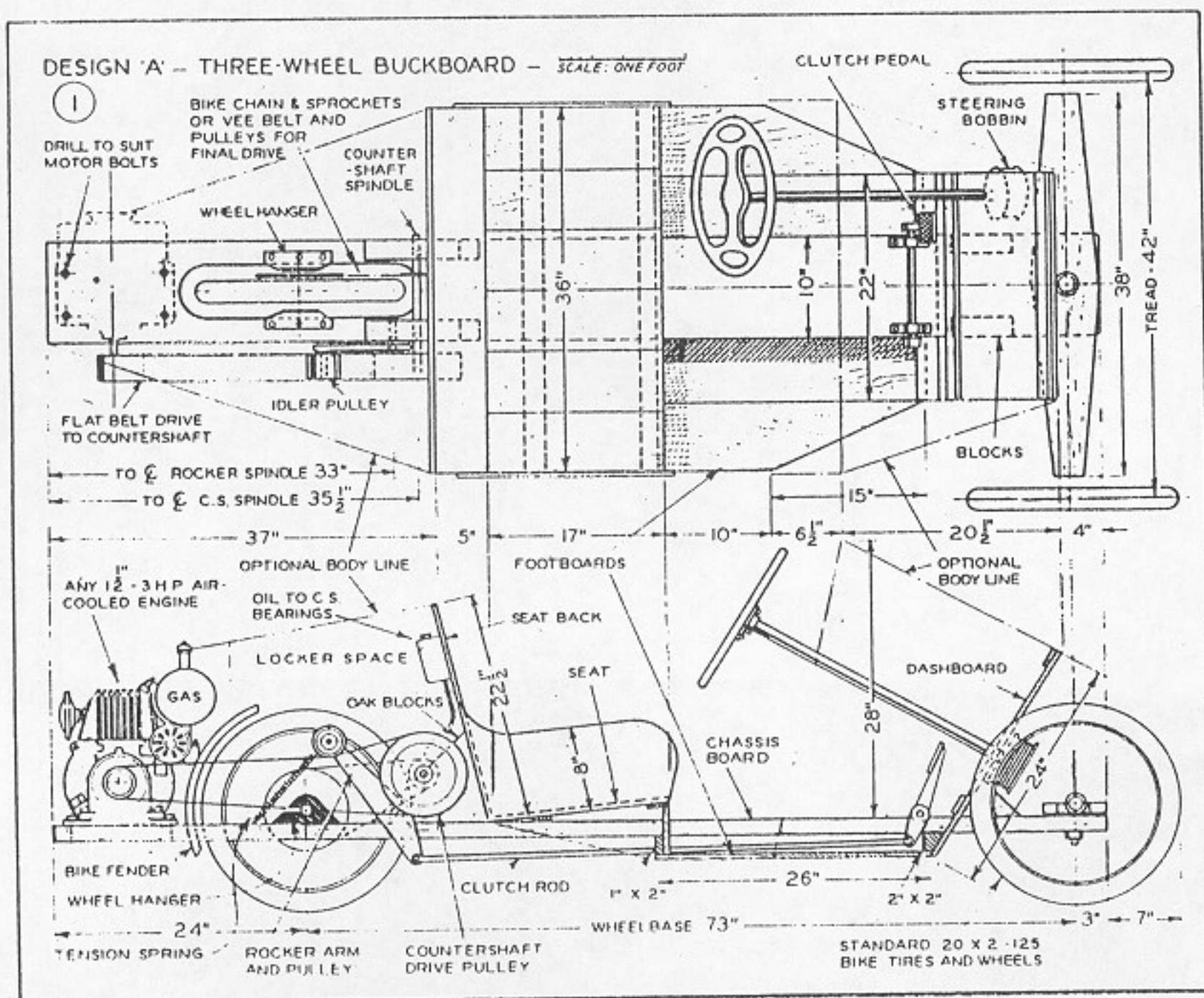
GAS BUSTERS

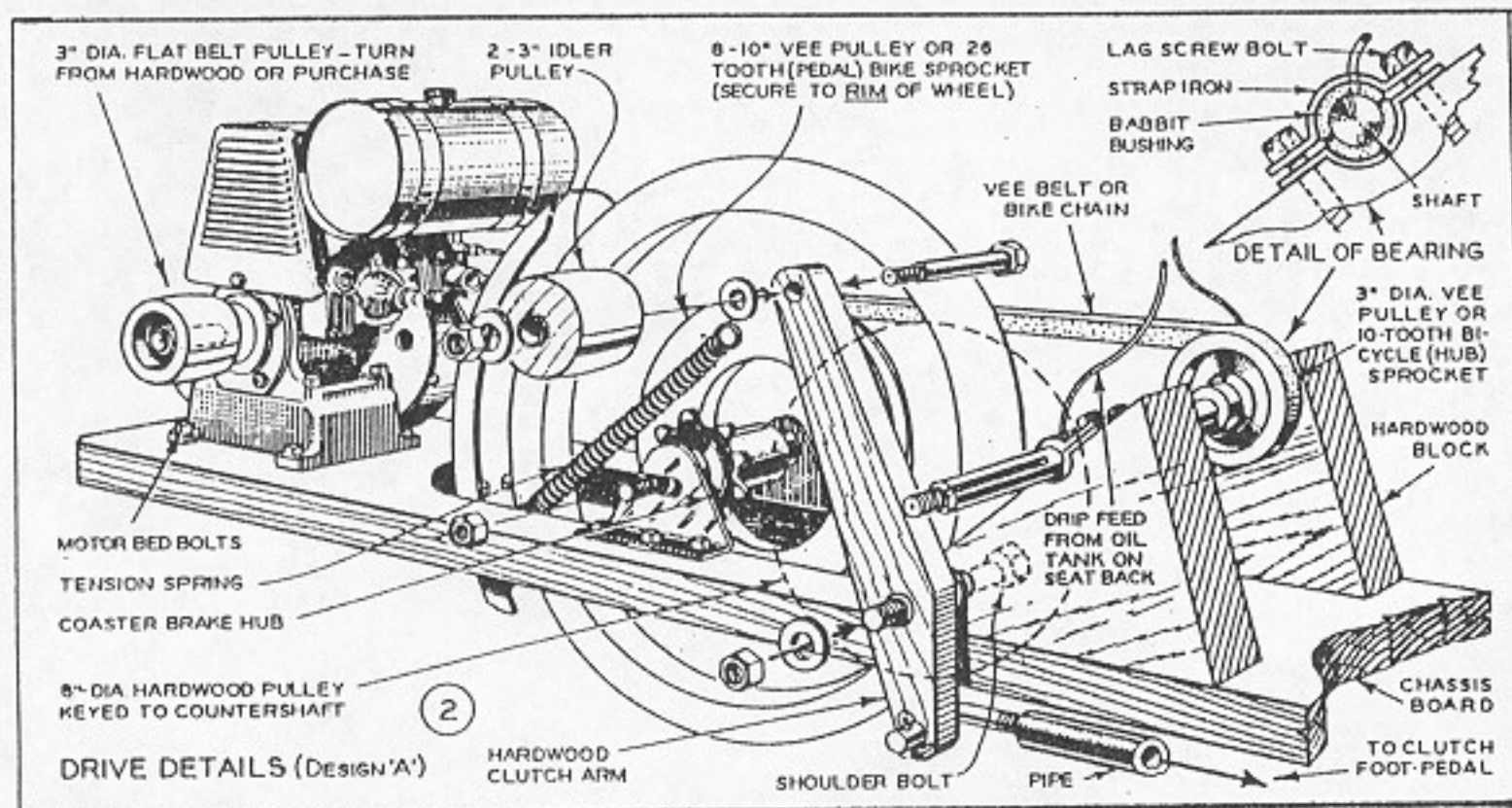
Mechanix Illustrated, 1943

THE difficulties of transportation today have sharpened interest in the small homemade car which even in normal times has been a number one workshop project. The chief problem is not so much how to build a small car but rather what materials to use. Quite apart from wheels and tires it is becoming increasingly difficult to procure the essential materials, particularly metal fittings. Even the old standby of the amateur car

builder, the junked car lot, has virtually disappeared and another famous source of material, the old model-T Ford, has gone with the wind. What then is the amateur car builder to do?

The answer is contained in a four-letter word, wood. This article demonstrates the possibilities of wood as a practical substitute for most of the structural members usually formed from metal. To illustrate the point

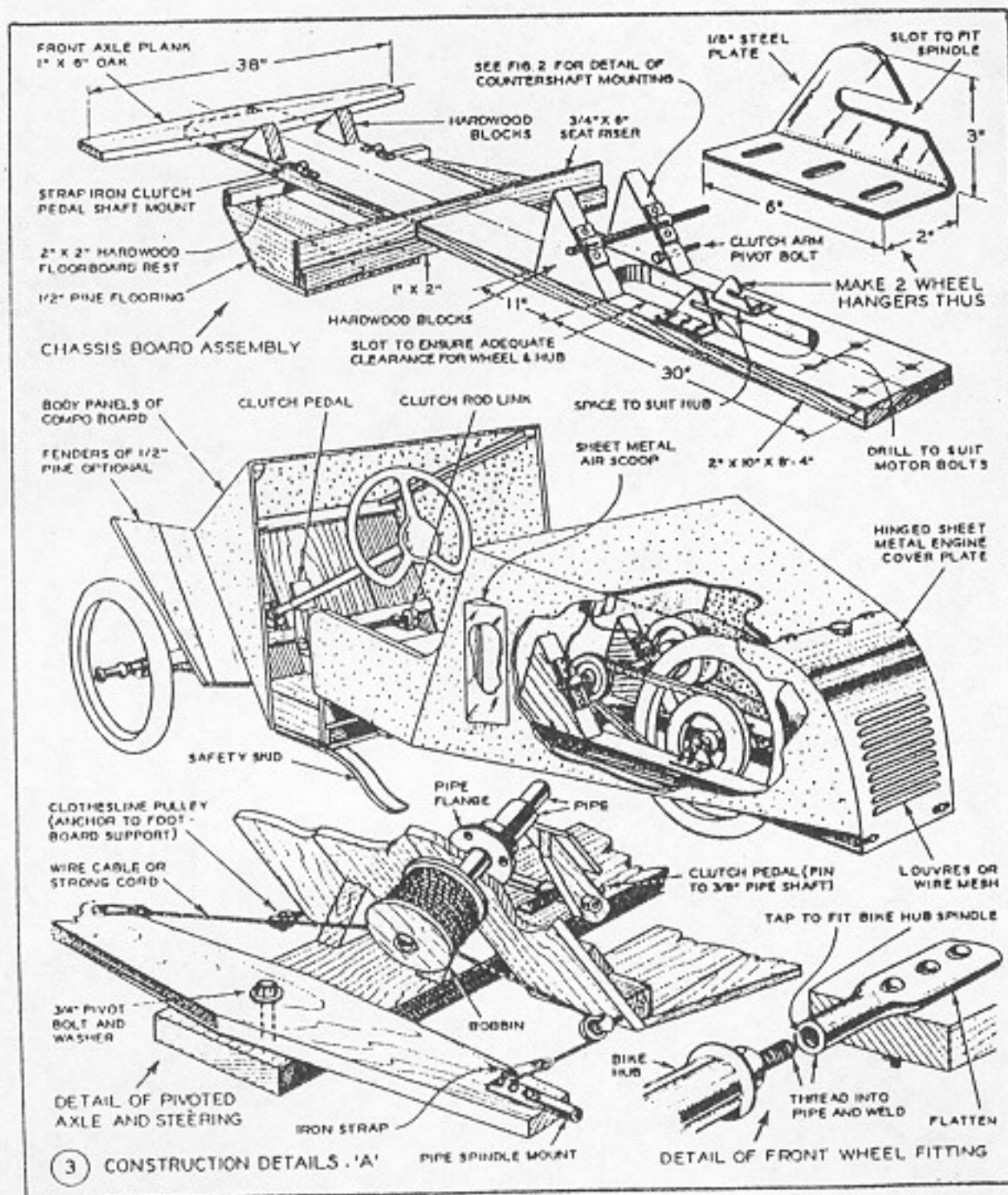




two designs are offered in some detail. Both designs are three-wheelers despite the fact that the three-wheeled car has never enjoyed much popularity in the U. S. A. The reason for this choice is economy of material and reduced cost—items of paramount importance at a time when such things as tires are as precious as diamonds.

The designs illustrated are based on the use of standard 20"x2" or 1.25 bike wheels and tires. Any other wheel and tire may be substituted, depending, of course, upon what material is available, but generally speaking, the larger 28-inch bike wheel is not satisfactory for the purpose and should be avoided. A much better proposition for wheels is to try and obtain some of the motorcycle type or even the small 12-inch air wheels which are often used on scooters and wheelbarrows. The 20x2 bike

The simple pivoted axle shown here and elsewhere in the drawings will do if you can't obtain an auto-type axle.



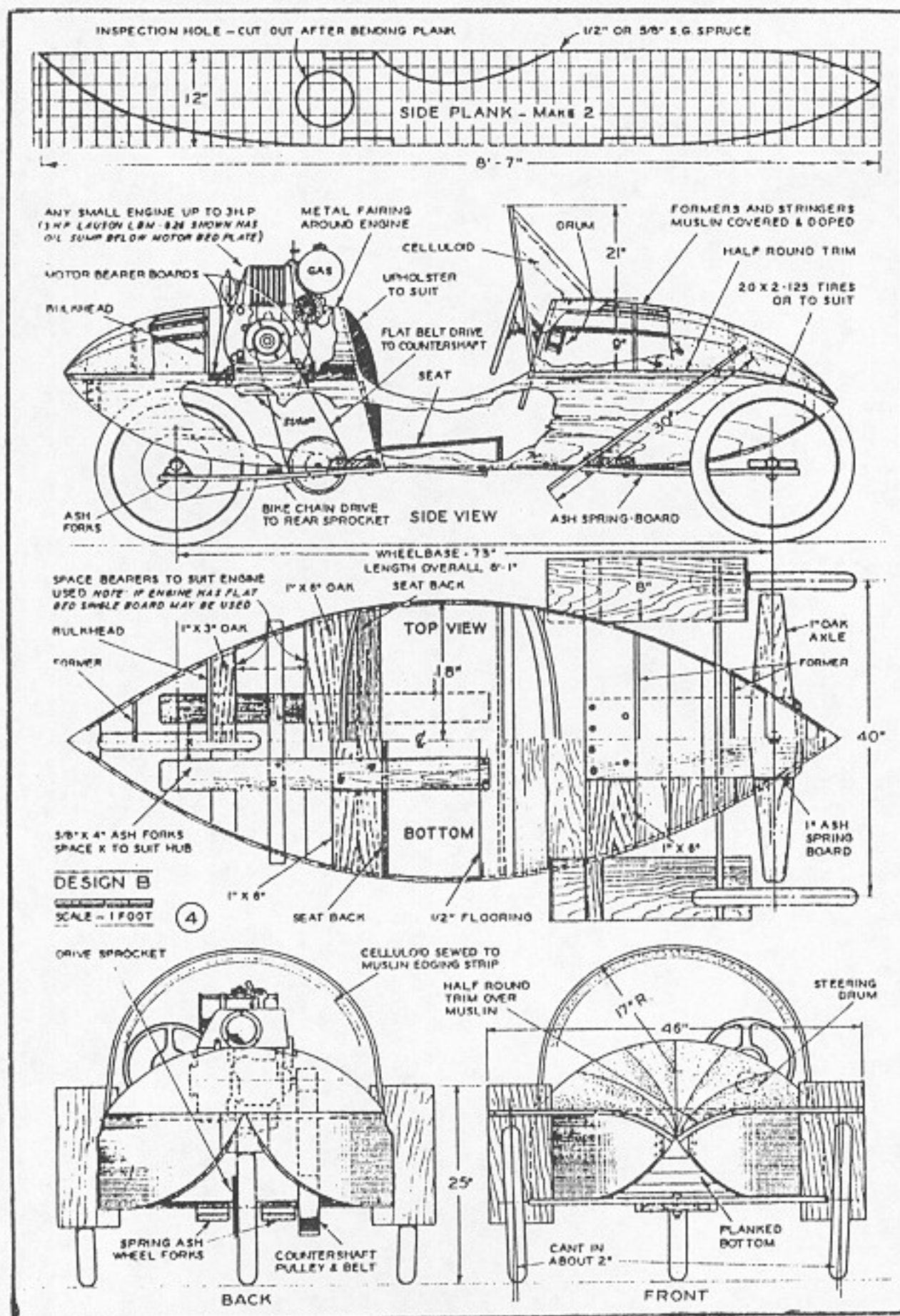
wheel has been selected as a happy medium and as the wheel most likely to be obtained under present conditions.

While on the subject of wheels it might be wise to point out that ordinary bike wheels, regardless of size, are not designed to withstand much power and that the spokes should never be used as the anchorage base for whatever pulleys and sprockets the drive system demands. In fitting pulleys and sprockets the base of anchorage should always be the wheel rim. Details of such a setup are shown in Fig. 11. It will be noticed that in this

method the power is taken up by the rim itself and besides being equally distributed the whole arrangement serves to strengthen rather than weaken the wheel. This is by no means an original idea and, indeed, a similar design was described in an MI project some years ago. Ordinary bike chains and sprockets should never be used to transmit power except as a last resort. You will notice that in the two designs given the final drive may be through bike chains and sprockets or V-pulleys and belts. If possible choose the latter. Speaking from

many years of experience with motorcycles the author is prepared to state that even motorcycle chains, which are far heavier than bike gear, are a source of trouble since the chain rollers and the sprocket teeth tend to wear down and permit the chain to jump or throw. Of course much more power is transmitted on the average motorcycle gear than is being considered in this article, but nevertheless bike chains and sprockets are not designed to transmit even such moderate power as that with which we are concerned, and any $\frac{5}{8}$ " V-belt is far superior for the final drive provided the tension is kept right and the belt is not allowed to slip.

The subject of slipping brings up another important feature of the tentative designs offered. With a fixed-gear drive of the type outlined in the drawings, the only provision for clutch action is afforded by slipping the belt, but

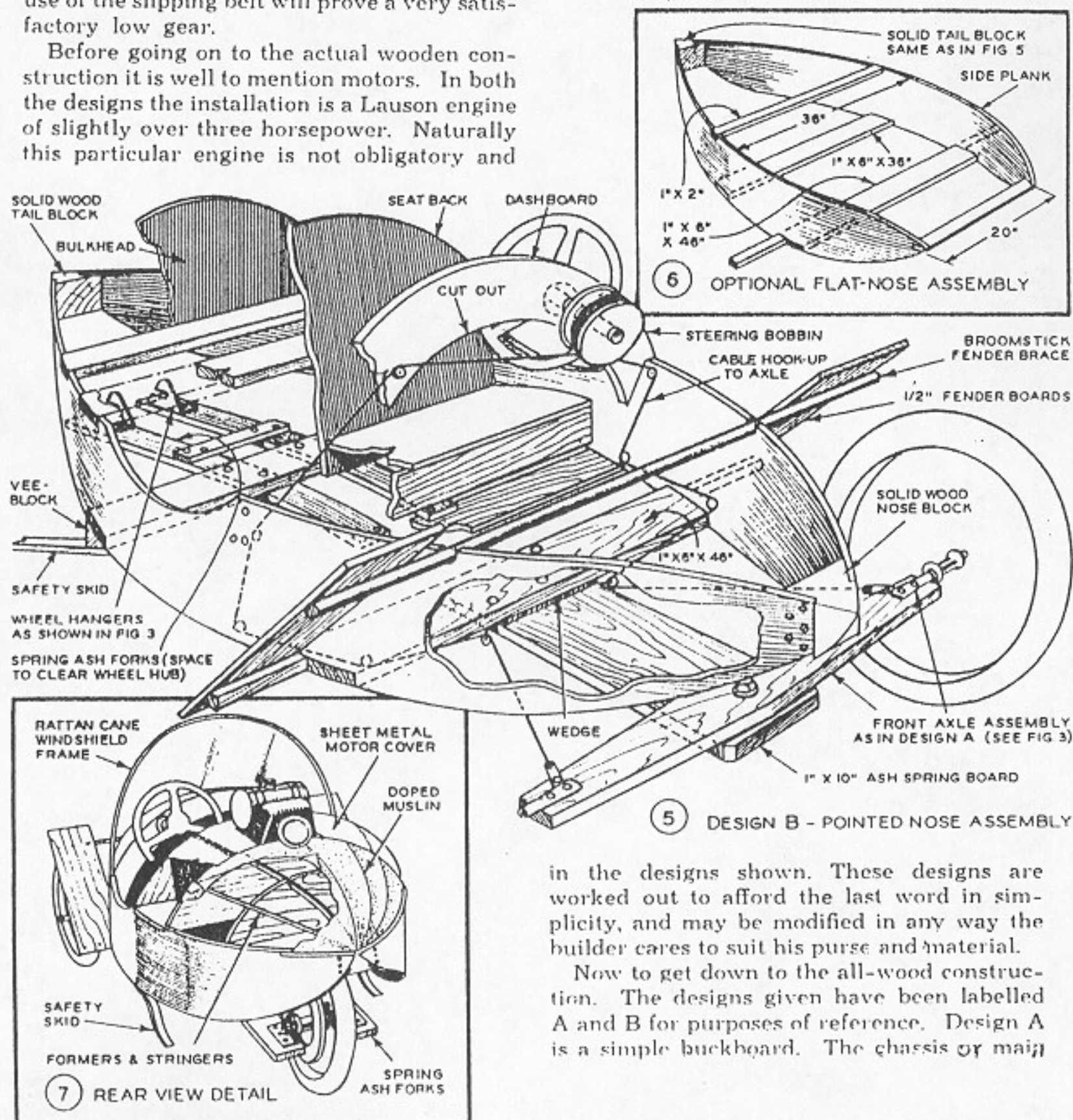


not the V-belt. Hence the resurrection of the flat-belt drive from motor to countershaft. The flat-belt drive has many advantages. It is highly efficient if given a fairly long coupling, it is not a rubber derivative and is therefore unrationed, and above all it permits the use of easily constructed wooden pulleys which may be turned up by anyone having a moderate knowledge of wood-lathe practice.

A two-speed gear and regular clutch would be desirable, but such things are beyond the facilities of most workshop fans and they are not strictly necessary for a runabout car of the type we have in mind. The fixed-gear with slipping flat-belt clutch will be found adequate for average driving and a judicious use of the slipping belt will prove a very satisfactory low gear.

Before going on to the actual wooden construction it is well to mention motors. In both the designs the installation is a Lauson engine of slightly over three horsepower. Naturally this particular engine is not obligatory and

any small air-cooled engine available may be used. Don't expect to get much performance with less than two horsepower. Three should be ample for fairly flat country, and with the gear reduction indicated speeds of about 30-35 miles per hour may be expected and a gas consumption of approximately one gallon per 100 miles. Kick or rope starters are used on these small engines and are very desirable features to bear in mind when looking around for the power plant. Finally, the drive hookup shown is not to be considered as anything other than a suggestion. Individual builders may have their own and possibly better ideas or they may have access to gears and other material which have been studiously avoided



in the designs shown. These designs are worked out to afford the last word in simplicity, and may be modified in any way the builder cares to suit his purse and material.

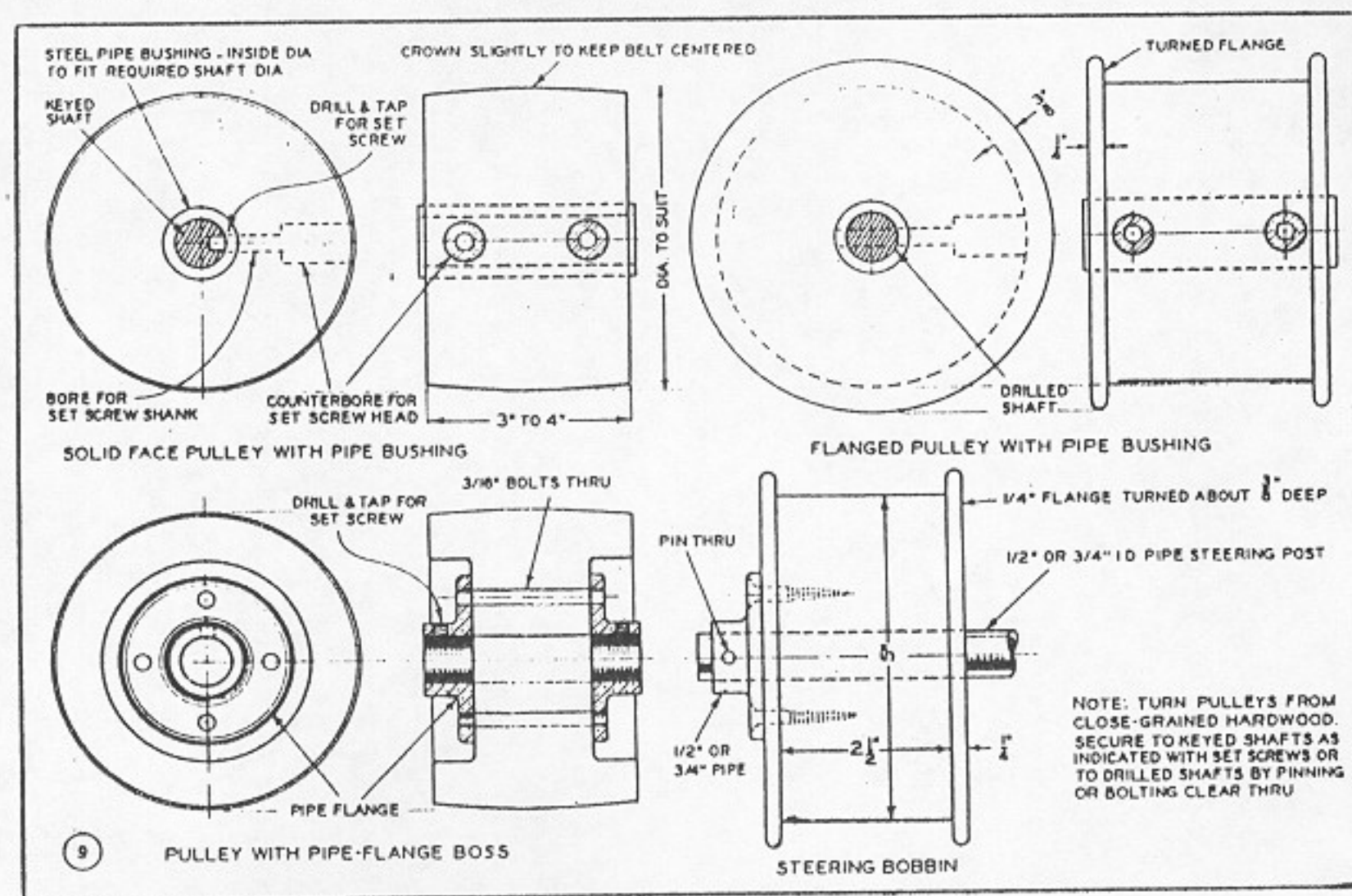
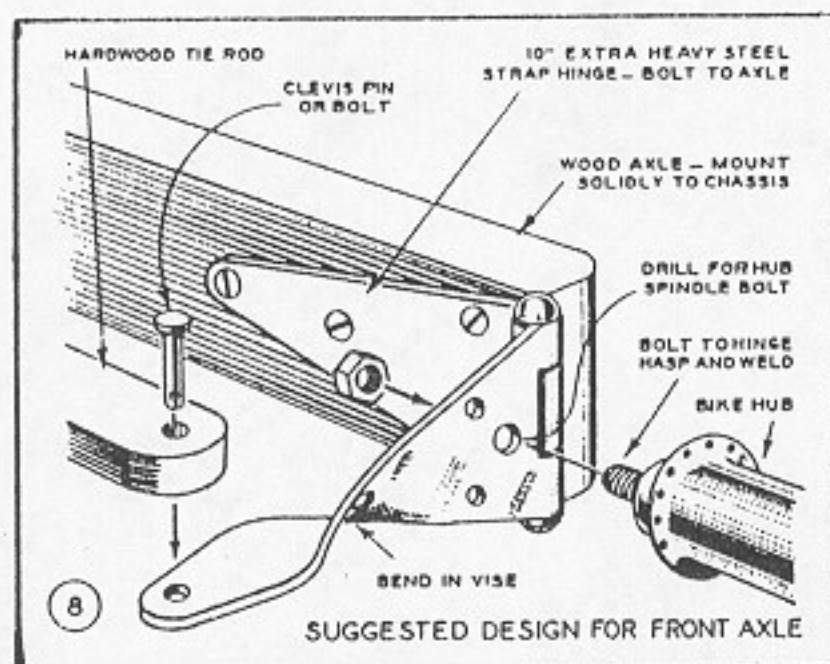
Now to get down to the all-wood construction. The designs given have been labelled A and B for purposes of reference. Design A is a simple buckboard. The chassis or main

frame member is nothing more than a 2"x10" plank and relies on its own resiliency for the springing. Upon this member rest the seats, the power plant, drive gear and the running gear. The slot for the rear wheel should be cut to suit the wheel actually used. Make the slot long enough to permit easy mounting of the wheel. Dimensions given in the drawings are based on the 20"x2" bike wheel and tire already referred to. The only metal parts required in this design may be counted on one hand and absolutely no metal machine work is necessary.

The countershaft is mounted on the blocks which serve to support the seat back. The belt

tensioner or "clutch" is also mounted on one of these blocks as shown. Countershaft bearings may be made as indicated in detail drawing Fig. 2 or they may be purchased. The babbitt-lined bearing shown is not difficult to make and with the constant drip oil feed suggested is sufficient for the purpose. The front axle as shown is merely a length of oak pivoted to the chassis plank. Steering is accomplished by means of a drum or bobbin and cable or rope as shown in the detail. If a regular auto type axle is available or if the builder has the facilities and ingenuity to construct such an axle, it is definitely to be preferred because while the pivoted axle is easy to make and install, it has certain inherent weaknesses which are particularly noticeable in a three-wheeled design. In any case if the pivoted axle is used the builder is advised to add two small safety skids at the seat station in order to minimize the danger of tip-overs. With such low ground clearance, however, this design is unlikely to tip. Smaller diameter wheels are not advisable for this particular design since the natural give or bend in the chassis plank will further reduce the already low clearance.

The buckboard design may be enclosed with a simple wall-board body if desired. Outlines for such a body are indicated in the drawings. Whether it be left in skeleton form or enclosed, design A makes a neat little tender or runabout for two adults and will

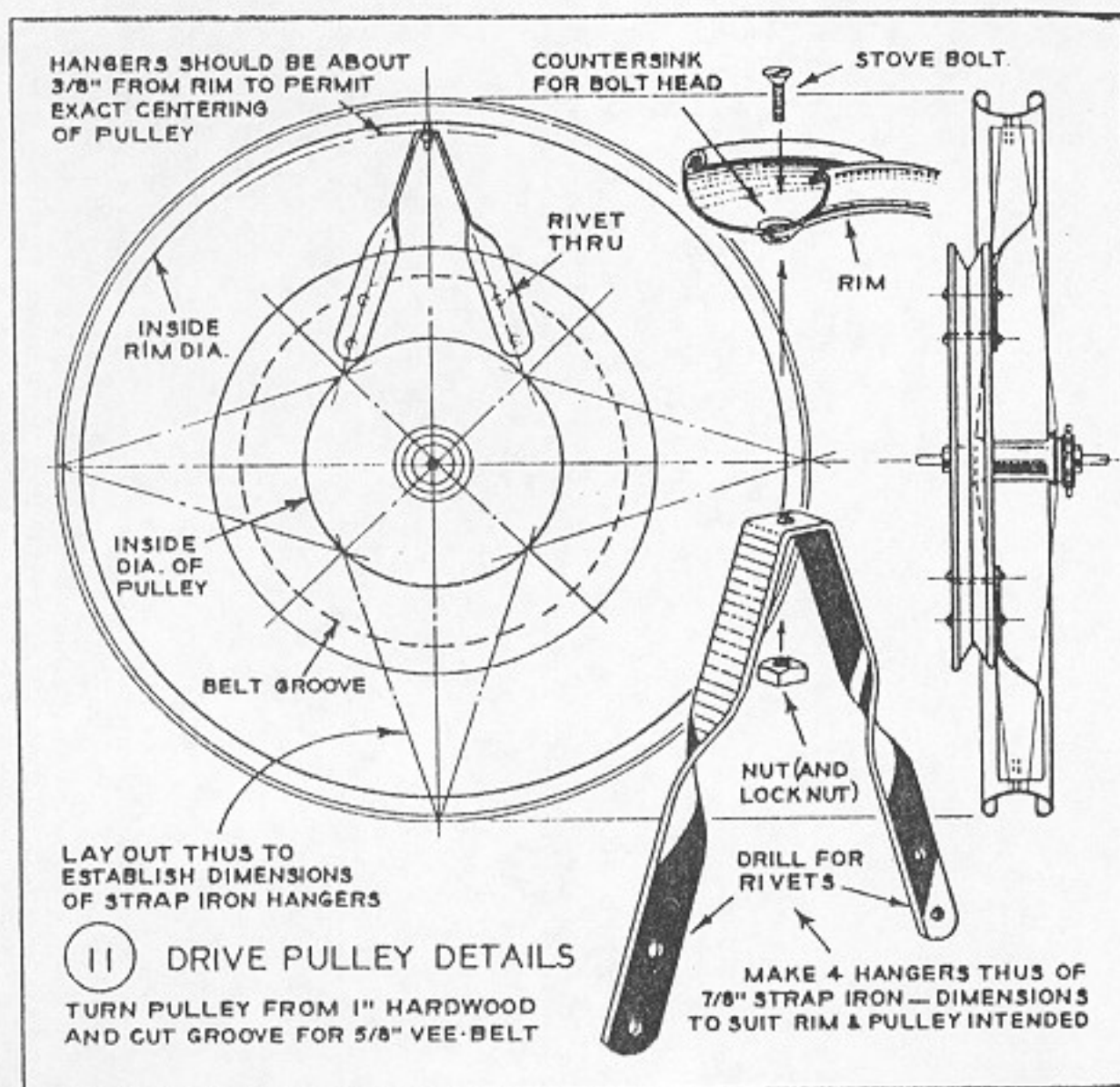
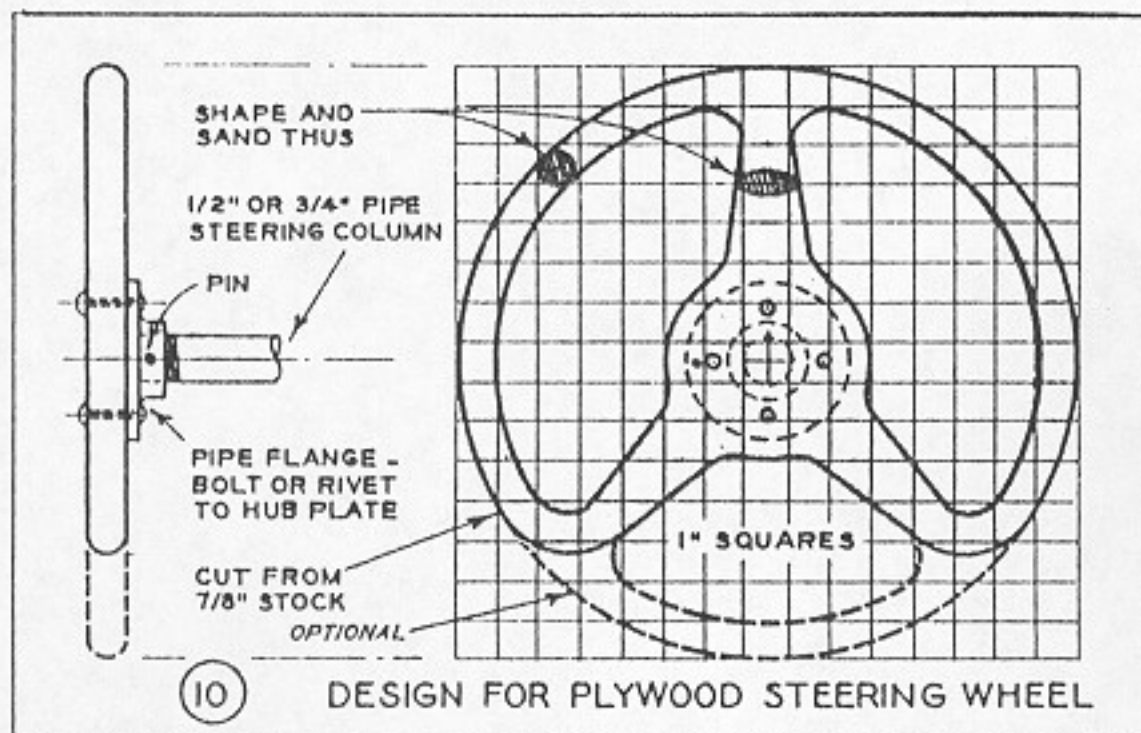


be found ideal for short hops to the bus stop, the railroad station and the local market. The drawings make no provision for a brake but the rear wheel is specified as having a coaster brake hub. Page 97 of the April issue of MI shows how the hub can be utilized as a very satisfactory brake. If you are unable to get a wheel with a coaster brake hub, is not difficult to devise a brake acting against the countershaft pulley, but the bike hub brake is to be preferred both for simplicity and efficiency.

Design B is a more ambitious project but hardly more trouble to construct than design A. In this instance the body and chassis are integral members and are formed quite simply by bending two 12" planks into what we may term approximately a canoe shape. In bending the planks it may be necessary to put in a few shallow saw cuts where the bend is most acute. This will depend upon the lumber used. If good quality straight-grained spruce is used for the side planks, a thorough steaming should suffice to ensure the bend. It is not essential that the ends be pointed as shown. By employing wider end blocks as in Fig. 6 the bend can be considerably reduced. The pointed design makes a neat job and is worth the trouble particularly when the job is faired in with the turtle-decking.

The motor shown in the drawings happens to have a dropped oil sump; and in consequence the motor-mount boards are divided. If the motor has a flat base, this is all to the good and in this

case the motor board can be a single cross plank notched into the side planks. The wheels are mounted on spring boards as shown. These should be of ash, the rear spring boards being spaced to suit the width of the hub. As in the "A" in the front axle is of the simple pivoted type. It is quite practical for the sort of use such a small car is likely to get, but safety skids are imperative in this,



Gas Busters

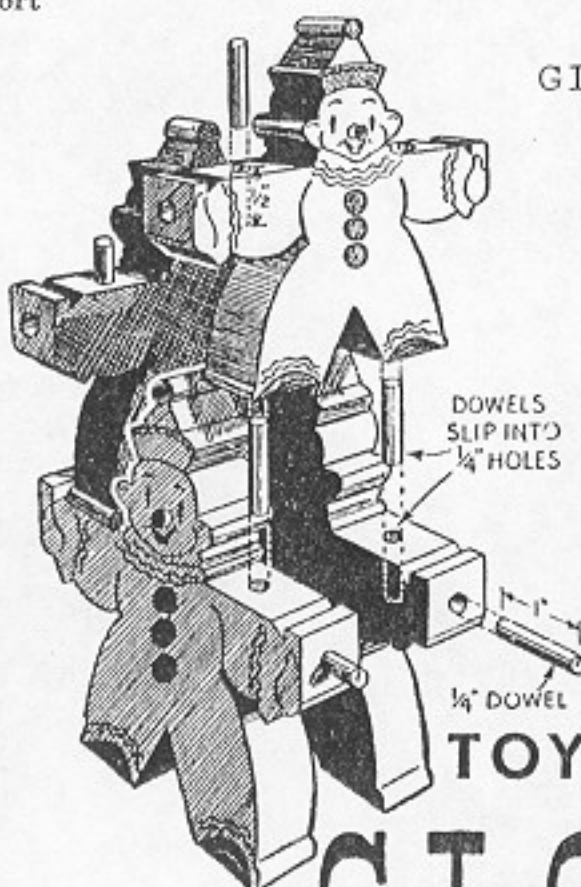
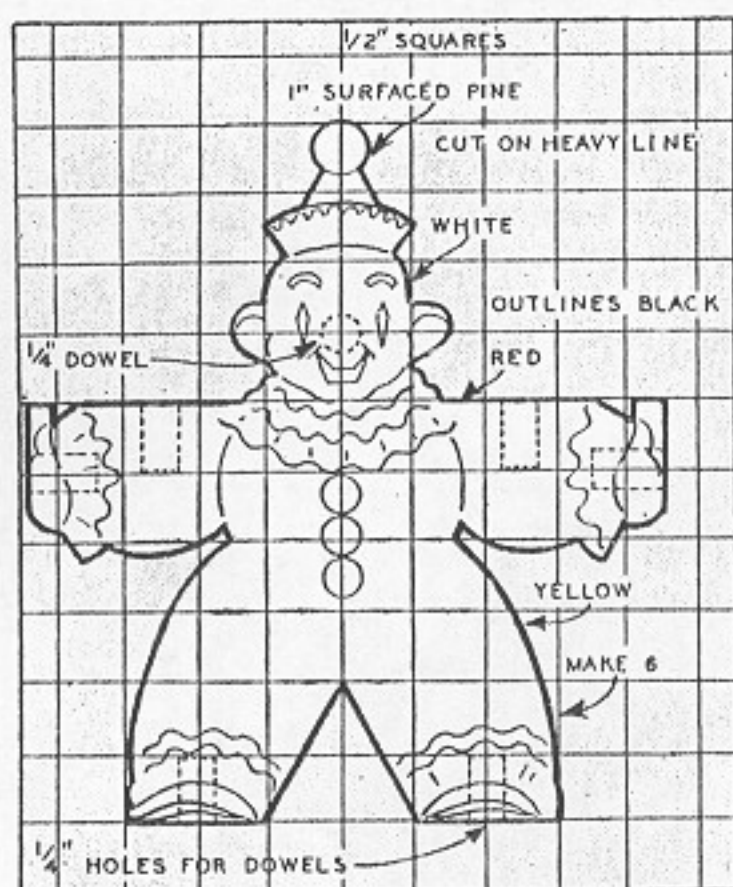
the "B" design. Skids should be located not further forward than the seat station and preferably in line with the rear wheel hub. Steering is the same as on the "A" design unless an auto-type axle (see Fig. 8) is employed. Even then the drum and cable system is suitable and easy to construct and adjust.

The body may be faired in with the turtle decking indicated. This is not hard to make and employs simple formers which may be cut from $\frac{1}{2}$ " stock or, if available, from plywood. Stringers should be notched in and the whole covered with unbleached muslin and then doped. At the motor station it is advisable to use metal fairing unless the exhaust is piped clear to minimize fire risks.

The only welding operation required in building either car is entailed in the construction of the front axle and this only if bike wheels are employed. The spindle of a bike hub is so short

that there is practically no purchase obtainable for rigid and secure attachment without forks. Therefore it is necessary to weld the spindle into a short length of tube which in turn is secured to the axle proper. Details of this are shown in the drawings.

Both designs are the result of extremely careful research and that both have been employed in a practical manner years ago when the ultra-light car craze was in vogue. The flat-belt main drive is not new in car design and has much to recommend it from the point of efficiency as well as cheapness. Whatever prejudice exists against the three-wheel design is largely unwarranted and is mostly a matter of appearance. In these times appearance is less important than mobility and if three wheels will do the work usually ascribed to four, a definite saving has been achieved.



GIANT HOME WORKSHOP

MANUAL 1941

TOY WOODEN CLOWNS

CAN BE ARRANGED
IN COUNTLESS WAYS

CHILDREN will be delighted with these colorful little clown acrobats because they can be put together so many ways.

Draw the design full size on paper; then trace six of the clowns on 1" surfaced pine stock, and cut them out with a jig saw. Drill holes $\frac{1}{4}$ " in diameter, or slightly larger, and $\frac{1}{2}$ " deep into the hands, shoulders, and feet of each clown as shown. Next, cut several 1" pieces of $\frac{1}{4}$ " dowel. These 1" lengths of dowel are the pins that hold the clowns together when they are built up one on the other, and they must slip in and out of the holes easily. Paint the figures for added appeal. Face and hands can be white, the suit yellow, trimmings red, buttons and shoes black.



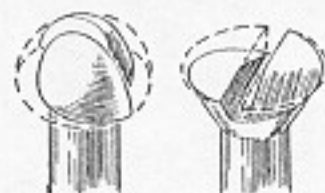
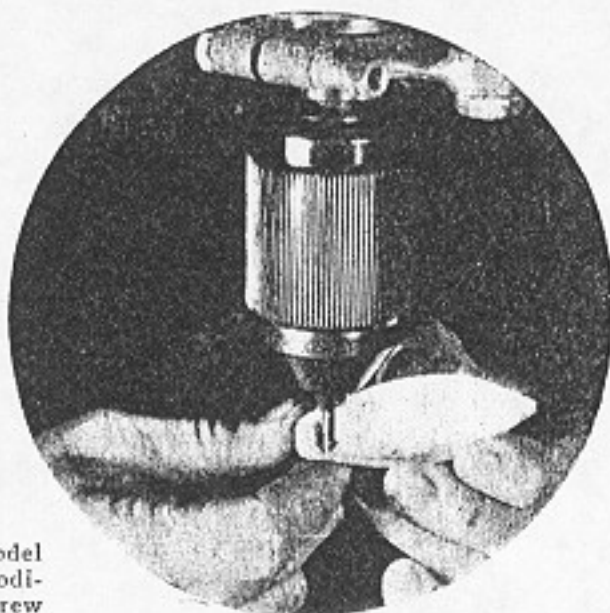
NEW TOOLS FOR YOUR DRILL PRESS

MODELS and other work may quickly be carved by the use of a tap in a drill press. Whirling at highest speed, the toothed flutes remove stock at a surprising speed, and cut across the grain without splintering. Scratches left in the work are soon removed with small reamers used in the same way.

For inside work, as in hollowing a lifeboat or other small piece, a quick job is done with a roundheaded wood screw held in a chuck on the drill press or lathe. To provide proper clearance, file away the side of the slot not used for cutting. A flathead screw treated in the same way makes an efficient routing cutter.

Very small dowel rods, useful for stanchions and railings, may be made by rotating hardwood meat skewers or $\frac{1}{4}$ -in. doweling at highest speed in a drill chuck and forcing one or more dies over it.

Hollowing a model lifeboat with modified roundhead screw



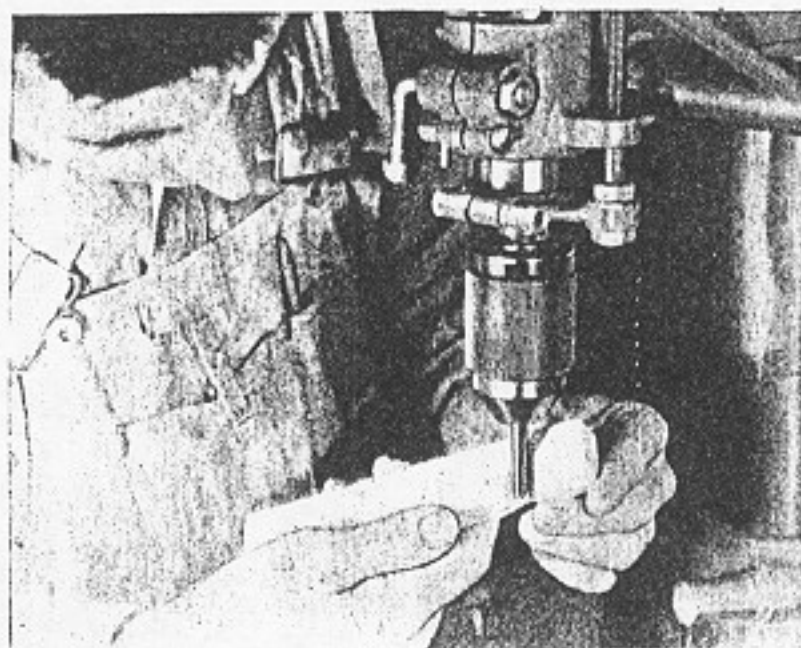
POPULAR SCIENCE MONTHLY

March, 1937



Small spindles and stanchions may be turned from wooden meat skewers and dowels with the aid of inexpensive threading dies

A tap, gripped in the drill-press chuck and whirling at high speed, is a good carving tool



Print of a Child's Hand Preserved in Plaster

A PRINT of a child's hand can easily be preserved in the form of a plaster plaque. Obtain a 6" wooden embroidery hoop and cut the inner hoop at one place so it will spring out when the outer hoop is withdrawn from it. Lay a board on a level, solid surface and place a sheet of white paper over it. Fit the cut hoop inside the outer one and lay them flat on the paper.

Mix plaster of Paris with water to a thick, creamy consistency and pour it inside the ring. When the mixture begins to harden, place the child's hand in the mold, fingers extended and spaced evenly. Press the fingers firmly, one at a time, and also press the hand itself into the plaster. Hold the hand down for several minutes until the plaster is no longer sticky. After the hand has been withdrawn, let the plaster set for half an hour. Remove the outer hoop, spring the in-

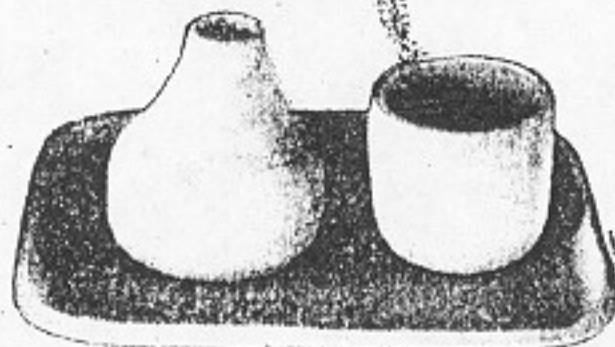


When pressed into soft plaster of Paris, the child's hand leaves a clear print as at right



ner hoop away from the plaque, and trim the paper to the size of the plaque. Then let the plaster dry thoroughly.

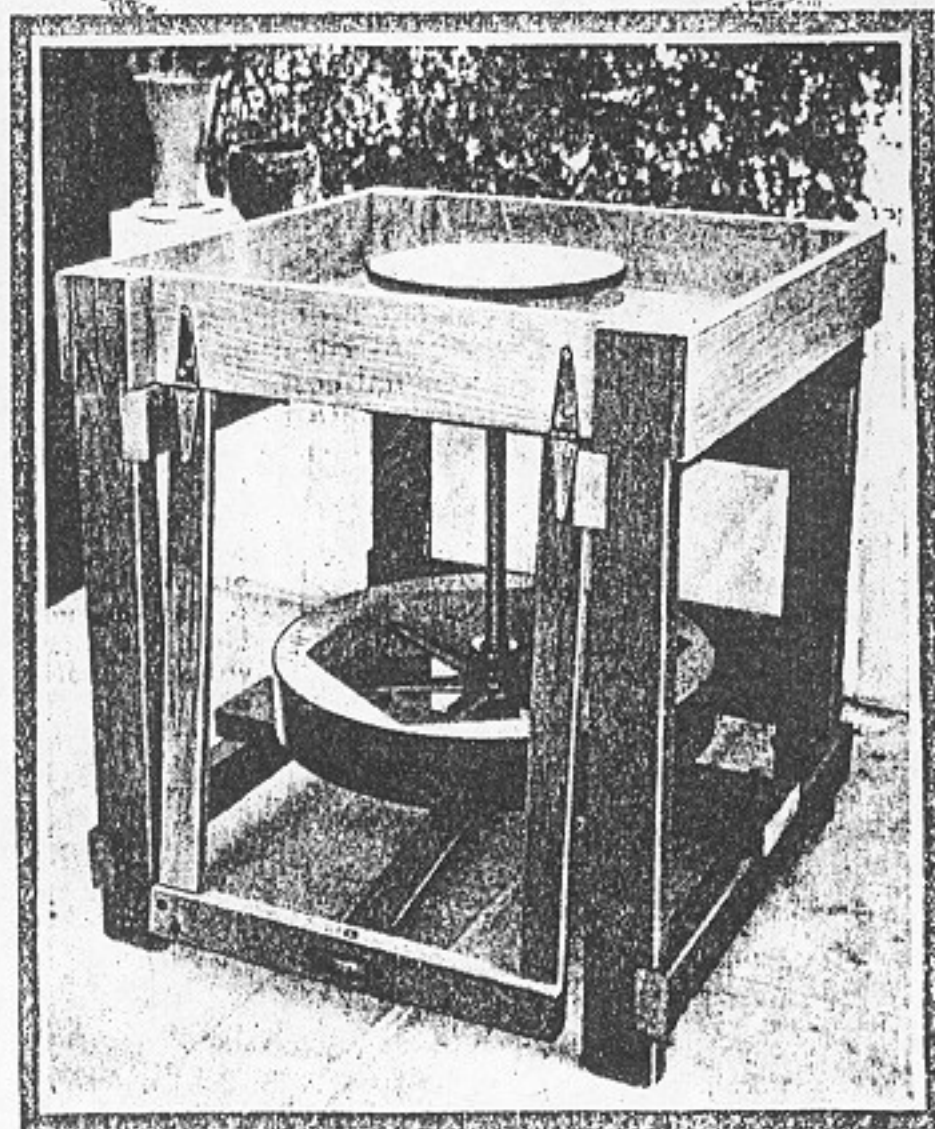
A pastel-shade paint will give depth to the hand print. For hanging, glue a loop of ribbon securely on the back.



THIS
INEXPENSIVE

Potter's Wheel

WILL START YOU ON AN
UNUSUALLY FASCINATING
AND PROFITABLE HOBBY

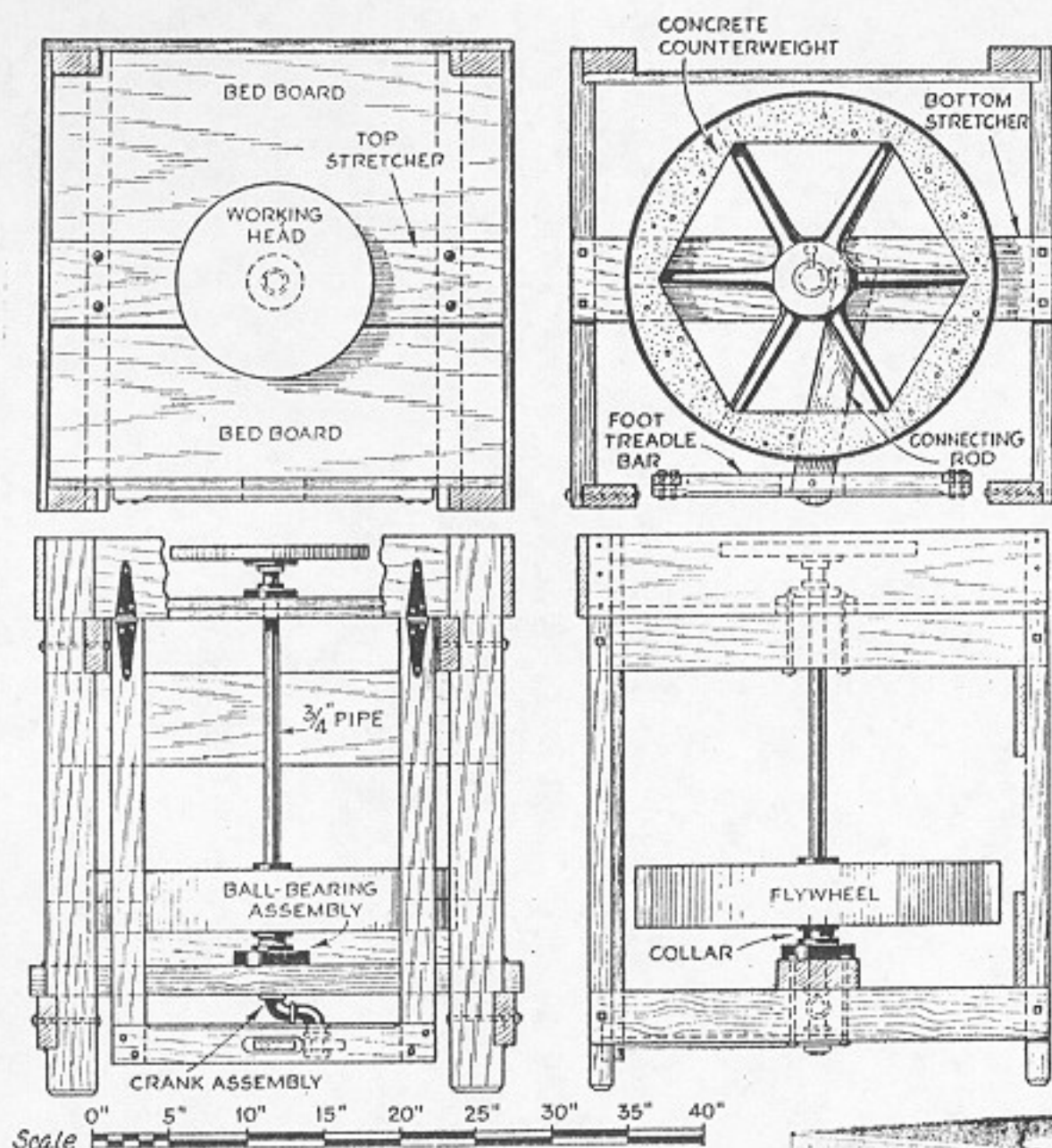


NO GREAT measure of technical skill is required to do pottery work, yet there is endless fascination in molding a lump of clay as it revolves upon the flying wheel. The potter experiences a thrill in feeling the clay give and spring magically into shape under the pressure of his fingers. It is, indeed, a craft that many amateurs could take up with pleasure and profit, especially as the principal tool—the potter's wheel—can be built at home.

The wheel illustrated is of an improved hanging-treadle type, with a short, nontiring stroke. Simple to construct, low in cost, and easy to operate, it has been thoroughly tried out by professional and amateur potters and has met with unqualified approval. The design permits its use not only for "throwing" or shaping the clay, but also for turning or finishing the leather-hard pieces with a lathe

On this improved potter's wheel of hanging treadle type, the amateur finds it is easy to make pieces like those shown





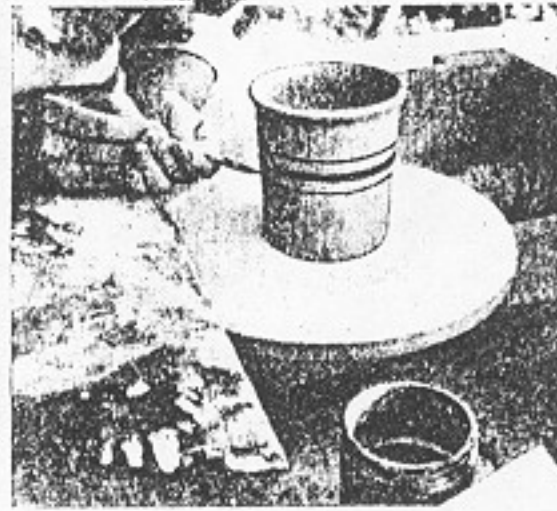
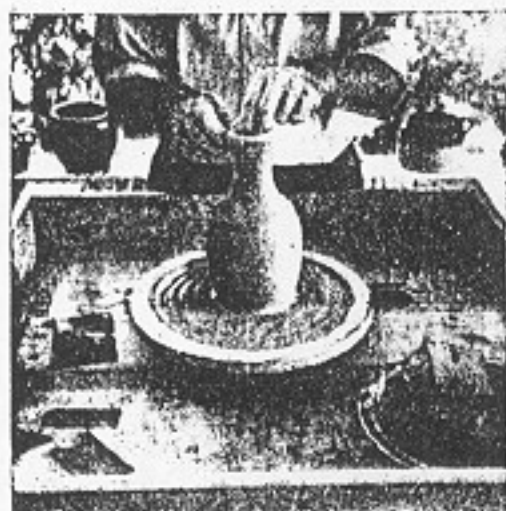
Left the assembly drawings. One is a top view with the box bed removed to show the flywheel and connecting rod



tool, and banding or brush decorating the biscuit-fired ware. The motion of the wheel is contraclockwise (from right to left), and this tightens the working head on the shaft and also tightens the pipe-crank assembly.

The construction will take about two days' time, and the cost (varying somewhat according to the type of flywheel used) should not exceed \$7.50. The materials are itemized in the list on a following page.

Below are the three principal operations—throwing, turning leather-hard pieces with a metal tool, and banding with a brush. At right, the treadle moves only $5\frac{1}{2}$ " at each stroke



As the narrowest dimension of the frame is 30", it may be well to determine beforehand whether or not the complete wheel will pass through the door into the room where it is to be used. If the door is too narrow, plan to do the final assembling within the workroom.

Start work on the frame by making the four legs. Each has two cuts, one where the top rail is bolted to it, and one where the bottom rail is bolted. Clamp all four pieces together when marking the position of the cuts. Place the top and bottom rails on the legs to mark the width of the cuts. Saw down to the depth line, remove the waste wood with a chisel, and bore $\frac{3}{8}$ " holes to receive the bolts. Mark the position of the bolt holes in the top and bottom rails and the bolts to fasten on the top and bottom stretchers, and bore these holes. Now bolt the rails to the legs.

Bore $1\frac{1}{2}$ " holes for the pipe shaft and $\frac{3}{8}$ " holes for bolts in the top and bottom stretchers, as

How the flywheel, bearing, plywood housing, and crank shaft are mounted on the main shaft

shown, and bolt these members in place. Screw the two crosspieces or ribbands to the back legs. Next screw the two pieces that form the box bottom or bed to the upper face of the top rails, fitting them snugly against the top stretcher and scribing them around the tops of the legs. Screw on the sides of the bed. This completes the framework.

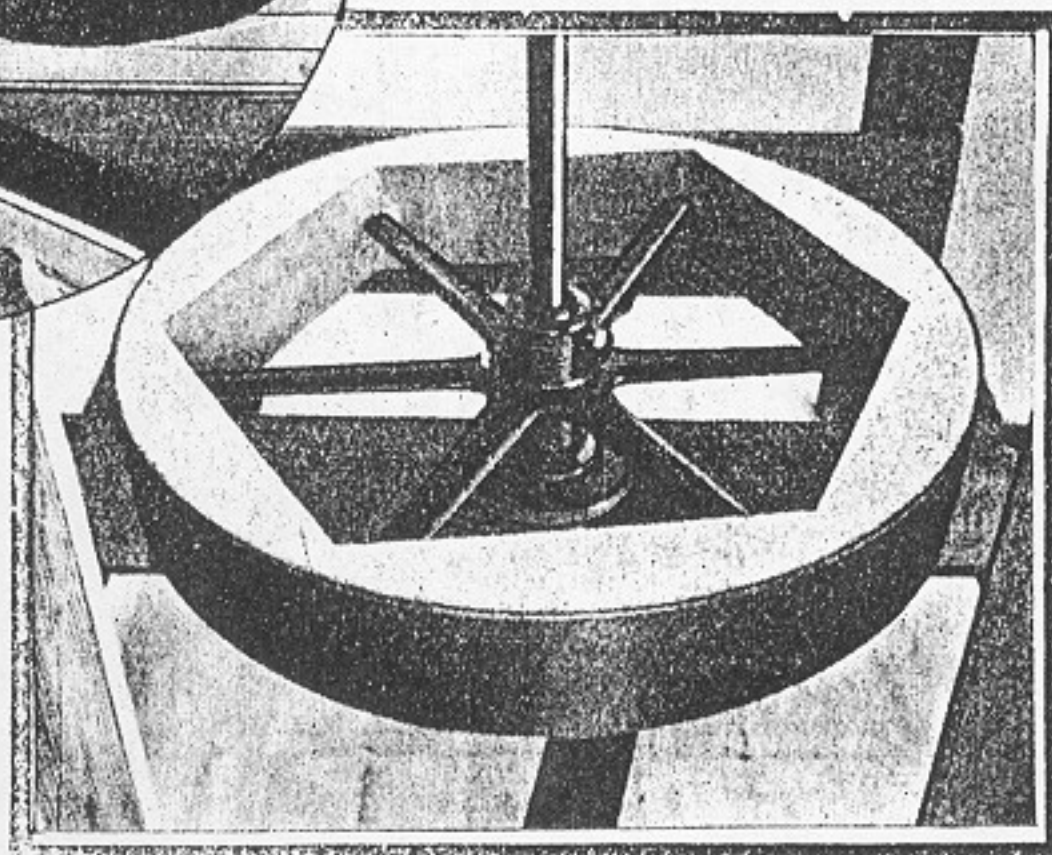
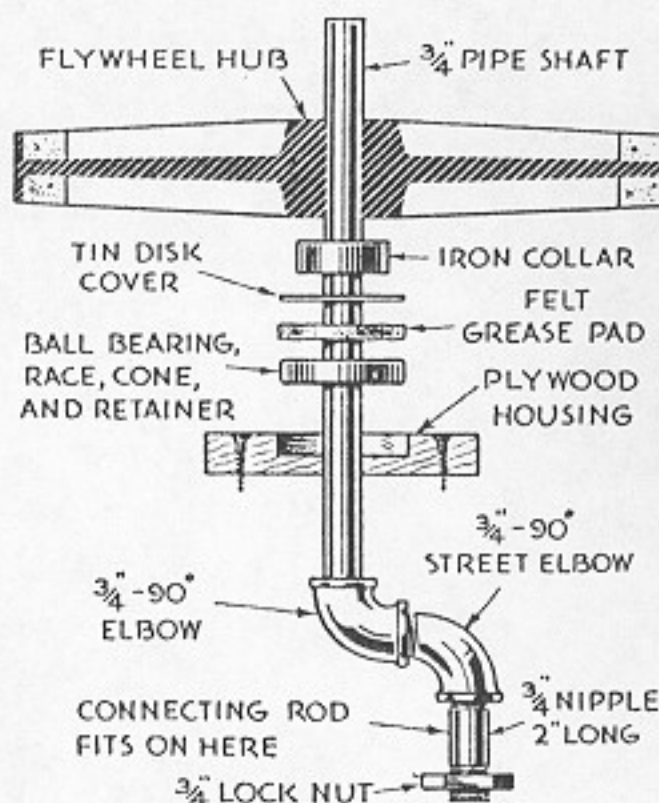
Make the wooden treadle and hang it in the position shown with two strap hinges. Prepare the wooden connecting rod, but bore only the larger hole—the one to receive the crankshaft—at this time, and set aside for the final assembly.

Next assemble the metal parts. If a light pulley of the set-screw type is to be used, it will be necessary to cast concrete around the outer edge, as was done with this one, in



If a comparatively light wheel or pulley is used, it can be given weight by fitting a form inside the rim and pouring in concrete

The flywheel weighs about 100 lb. with the concrete rim. Any heavy wheel from 18" to 24" in diameter will do



LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
4	Legs	1½	3½	36½
4	Rails	1½	3½	30
1	Top stretcher	1½	5½	30
1	Bottom stretcher	2	5½	32½
2	Ribbands	¾	6	30
3	Front and sides of box	¾	5½	30
1	Back of box	¾	5½	31½
1	Bottom of box	¾	10	30
1	Bottom of box	¾	12	30
2	Treadle hangers	¾	2¼	28¾
1	Treadle foot bar	1½	2½	21
1	Connecting rod	¾	2¾	17
1	Working head, 5-ply	¾	13 diameter	
1	Ball-bearing housing, 5-ply	¾	5 diameter	

NOTE: Dimensions are given in inches and are finished sizes. Soft wood, such as pine or Douglas fir, may be used for all parts except the connecting rod, which should be of oak or other hard wood.

MISCELLANEOUS

- 1 pr. 8" light steel strap hinges with ⅝" wood screws.
- Carriage bolts: 4—5" by ⅝"; 8—6" by ⅝"; 4—2" by ¼"; 1—3" by ⅝".
- Flathead bright wood screws: 36—1¼" No. 8; 8—¾" No. 14.
- 1 pc. ¾" black iron pipe 28" long, threaded both ends, for shaft.
- 1 complete ball bearing to fit pipe shaft.
- 2—¾" x 3½" pipe floor flanges. One should be reamed to form a guide for the shaft. The other is to fasten the working head to the top of the shaft.
- 1—¾" flat band, straight 90-deg. pipe elbow.
- 1—¾" flat band, street elbow, 90 deg.
- 1—¾" by 2" pipe nipple.
- 1—¾" pipe lock nut.

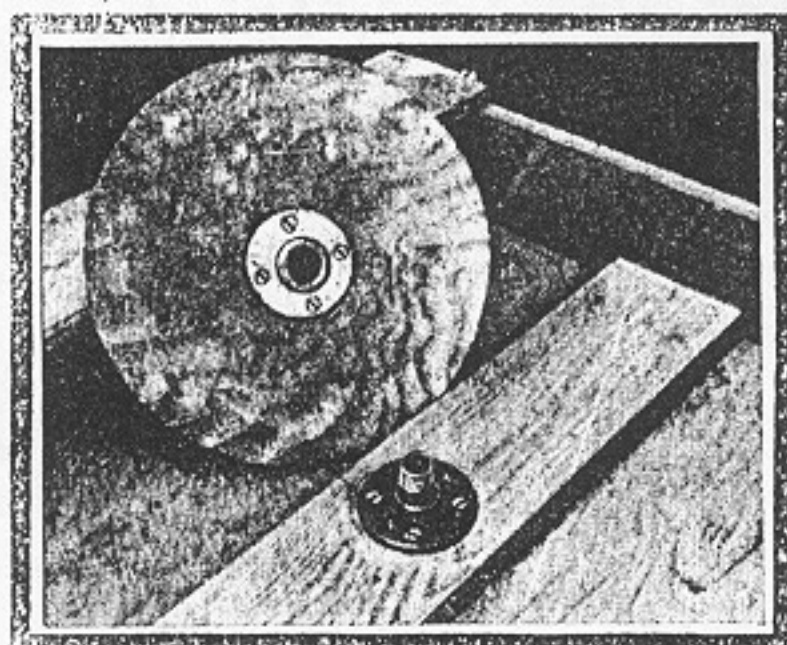
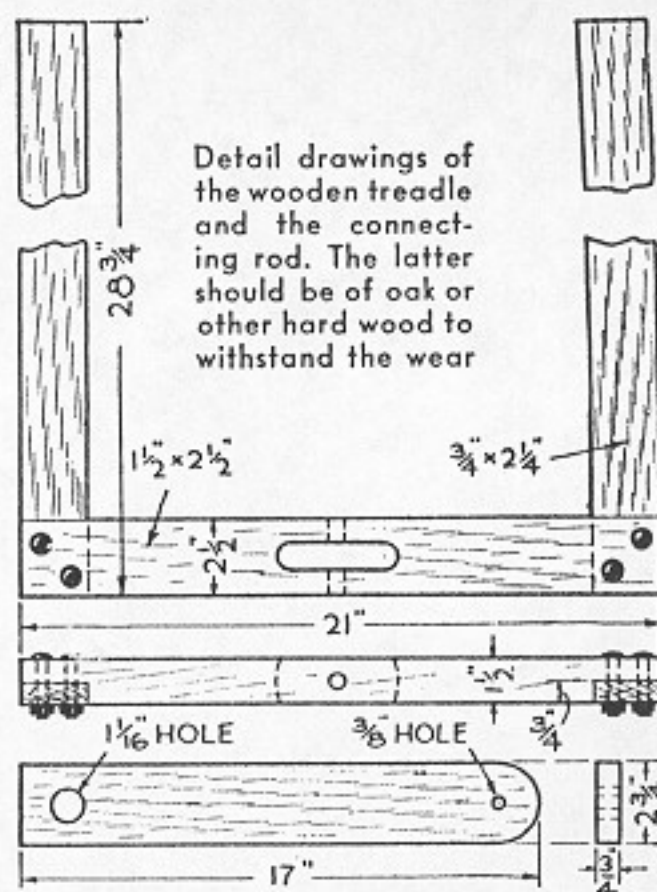
NOTE: All pipe fittings are ordinary black iron.

order to provide sufficient weight. Small strips of wood fitted around the spokes will make the inside form, and the inside face or rim of the pulley will provide the outside form. Use a concrete mixture consisting of one part Portland cement, two parts clean, sharp sand, and three parts gravel or crushed stone with a maximum size of ¼".

The wheel used in this instance has a 4" face, and with the concrete rim weighs about 100 lb. Either an old flywheel taken from a gas engine, or an old automobile or farm implement wheel weighted with concrete and provided with a set screw or two for locking it against the pipe shaft, is satisfactory. The wheel in the model shown happened to have a slight flaw in the hub and was purchased secondhand for 75 cents. The maximum diameter for the flywheel is 24". An 18" wheel, if heavy enough, will do equally well.

The wheel shaft is a piece of ¾" black iron pipe, threaded at each end. The outside diameter of the pipe will vary from about 1 1/16" to slightly over 1½", so obtain a wheel bored to fit the size pipe you use; or if the hole is somewhat larger, provide a metal shim to make a tight fit.

When selecting a ball bearing, keep the size of the pipe shaft in mind and get one of



A ¾" floor flange is screwed under the working head. The other flange is reamed to fit the shaft

the actual size or only slightly larger. The bearing used in the wheel illustrated cost 25 cents secondhand at an auto-wrecking yard. A good bearing may also be obtained at almost any garage or machine shop.

Bore a hole in a 5" disk of ¾" five-ply board to receive the ball bearing and shaft, being particular to see that the parts revolve freely. Attach this wooden housing with four screws in position directly over the hole in the bottom stretcher. Set the flywheel directly on top of the ball bearing in such position that the holes are all in alignment.

If the hub of the wheel does not fit the ball bearing, a metal collar may have to be placed between the wheel hub and the bearing. Lower the pipe shaft through the hole in the top stretcher, pass it through the wheel hub and

ball bearing, and allow it to project $\frac{3}{4}$ " below the lower face of the bottom stretcher. When in this position, lock the flywheel tightly in place by tightening the set screw or screws in the hub.

Screw on the pipe elbows that form the crank, and tighten them and the short pipe nipple (crankshaft) with a pipe wrench. Next, attach the pipe floor-flange guide, through which the top of the pipe shaft works, to the upper face of the top stretcher. Adjust the position by observing the motion of the shaft before finally screwing it in place.

Slip the connecting rod through the slot in the treadle foot bar and up over the nipple screwed into the street ell, and hold it in place with the lock nut screwed up loosely. Next, find the exact place to drill the hole to receive the bolt in the foot bar, and as there is more or less variation in different pipe fittings, this must be worked out in actual operation. Turn the flywheel so that the crank is parallel to the bottom stretcher. This is the halfway position of the crank stroke. With the treadle exactly plumb with the front legs, insert an awl or sharp nail through the hole in the upper face of the foot bar and force it slightly into the connecting rod so that it cannot easily slip out.

Now turn the flywheel slowly around, allowing the crank and connecting rod to move the treadle. When you find that the assembly works smoothly, remove the connecting rod and bore a $\frac{3}{8}$ " hole in the proper position. Then connect up the "power plant" and tighten the lock nut securely.

All that remains is to attach a $\frac{3}{4}$ " pipe floor flange to the bottom face of the plywood working head and screw this assembly onto the upper end of the pipe shaft. The wheel is then ready for work. It should have an occasional oiling at the guide on the top stretcher and at the working ends of the crankshaft. The ball bearing should be kept well greased. It is a good plan to provide a felt pad with a tin cover over the ball bearing. The pad and cover can be slotted and slipped over the shaft or collar, or they may be a part of the whole assembly and set in position at the time the shaft is dropped into place.

The frame and outside of the box may be painted or varnished, but the inside should be left as it is so that no paint is scraped up with the clay when cleaning up the box. After considerable use, some play will be noticed in the connecting-rod bearings, but thin brass shims will correct this.

BUYING UNREGISTERED GUNS

by Kurt Saxon

Most guns bought at gun shows are unregistered as are those bought at most stores, especially in the South. The "registered" gun is that paid for and left at the shop until the police check your credentials.

In the South, however, and at gun shows, there is a record of purchase which the police never see unless the gun is found after the commission of a crime. So there is a big difference between the gun registered by the police and the gun which is simply recorded as having been purchased by you from a certain store or person.

If your gun is registered by the police and someone in your area is shot by one of the same caliber, your gun might be called in for a ballistics check. But if it is simply recorded as a sale, as said above, no attention will be called to it unless it is found after the commission of a crime. Then it could be traced to the seller and then to you. Had you reported it stolen and there was no evidence putting you at the scene, you would not be in trouble.

But say you wanted no record of any kind that you had bought the gun. The gun show is the best place for finding dealers who will just hand you the wea-

pon in exchange for the cash.

The best way to spot such a one is if his table is cluttered with various items besides guns. In this case he's most likely to be selling off his own guns or doing a favor for a friend. He will probably hand over the gun with no questions asked.

If a dealer at the show wants to record the statistics of the sale, you might show him your I.D., but tell him you are paranoid after having seen "Red Dawn" and don't want your purchase recorded. In most cases he'll just check your I.D. to make sure you are a resident of that state and take your money; if he won't, just go to the next table.

Another way to pick up guns with no record is to simply wear a 3 x 5 card on your chest saying, "Pistols Wanted". A lot of people who want to make a few bucks without renting a table will bring firearms to the gun show, buy a ticket and collar people showing interest in guns at the tables. If the person looking walks away, such a one will approach him and say something like, "I've got some good deals in my duffle bag."

These are strictly non-business types who may be down on their luck and want more for their guns than they could get

from a pawn shop. They will be attracted to your sign.

This is the simplest kind of no-record sale. But you should make them show you their driver's license to make sure they aren't some kind of cop setting you up. Even so, chances of such a thing are too slim to worry about. There are so many people milling about at gun shows and the police and ATF are so understaffed and dealers are so anxious to sell, that such infractions are impossible to watch for on any effective basis.

Actually, recording sales and even police registration should not bother anyone just wanting a gun for his home. I advise legality for your own peace of mind.

But say you live in an area such as New York City where handguns are banned, period. Say also that you want to buy guns and sell them to friends there at a profit.

You would need to drive to an out-of-state gun show such as held in Florida. Since you would need a Florida driver's license, you have the option of visiting there a couple of weeks to establish residence or getting a phoney I.D.

STRIP FOR ACTION

by Kurt Saxon

Getting into any business is a major step for one who has depended on others for his weekly paycheck. But once you have made money through your own efforts, you get a feeling of confidence and self-esteem which will help pull you through most any future crisis. You will also develop an awareness of the mechanics of trade, indispensable to anyone who means to be successful.

So whether you are out of work or are an executive behind a desk, learn to play the game. Join the Underground Economy, even as a weekend hobby, and see how far up the ladder you can go using your own abilities.

However far you go, whether you prove to yourself that you can make a few extra bucks or establish an empire, you'll learn, firsthand, the difference between the inferior, the mediocre and the superior person. Following this program will also teach you the money-making secret of the ages, by which all truly superior people have established permanent success for themselves and dynasties for their descendents.

The first step toward true success is to start at the bottom. When you've made your way up to the top you can hire people to add polish and frills and do the detail work you no longer have time for. But to be the boss, and stay the boss, you've got to know the guts of the game at every level by firsthand experience.

Aside from firsthand experience, the best tool for success is self-discipline in fair dealing and honesty. Lying, stealing and cheating are the tactics of a dependent, a parasite, a loser. No matter how far the parasite gets, the man who has made it without such ruinous shortcuts can knock him on his back every time.

The hardest, but the surest guarantee of keeping what you have is the motto, "I don't want what I can't earn."

Write that down and paste it on your shaving mirror. Drum it into your subconscious with every act in your career. It will make you more alert and stronger. It will also allow you to step on, without any misplaced compassion, any degenerate who tries to take unfair advantage of you.

The best way to begin your quest towards weapons Czardom is with a garage or yard sale. This serves a two-fold purpose. The first is to learn to wheel and deal on a very basic level. The second is to clear your quarters of all the unused items you've had lying around which you know you don't really need

and never will.

If you're a family man you must not create a riot by looting your children's toy box or stripping your wife's closet. You're not going to get enough for second-hand goods to cause bad feelings. Anything of theirs must be freely donated.

You'd be surprised at how much you've bought over the years, got your money's worth from and will never miss. Also, by marking it half price or less, you'd be surprised at how much cash you can clear over a weekend.

If you live in a block of apartments where garage or yard sales aren't allowed, there is always the flea market. They are in every city and town in the U.S. and a table usually only costs about \$10.00.

Flea markets are usually more lucrative, but only so much can be piled on one table. So, if you can work a garage sale, that's the best place to clear odds and ends of what even you would consider plain junk.

After a couple of weeks at working garage sales you'll have a general idea of what the casual bargain-hunting public will buy. Then to get more items, you can even make the rounds of garage and yard sales in the suburbs and buy up pretty good items to take to the flea market. You'll also pick up more experience. By this time you can take your earnings to police and general auctions and get fantastic buys to take to the flea market. Incidentally, garage and yard sales, flea markets and auctions are all advertised in the classifieds of any local paper.

When you've learned to deal with the bargain-hunting public and know how to price various items, it's time to hit the gun shows. Although you can take weapons to flea markets, there is seldom enough money brought there to be worth your gamble in time and effort.

There are two basic ways to collect weapons to take to gun shows without paying for them. One way is to advertise in the local classifieds, "Wanted: guns, ammo, knives, etc., to take to gun show on consignment. Name, phone number." You'd be surprised how many people in your area have such goods they've had for years and would like to get rid of for a few dollars. For such dealings you'll have to know something about pricing.

You must also be willing to show them your I.D. and give them your home address to gain their confidence. The fair

deal on such transactions is to give them two-thirds of the sale price, taking one-third as your profit.

Two other sources for such weaponry are gunsmiths and pawn shops. With all the above it's best to have an FFL. That makes your identification easy. The pawn shop proprietor usually has loads of unredeemed guns lying around, as does the gunsmith. Since they're usually closed over the weekends and always on Sunday, you'd be a good outlet for stock they'd otherwise find hard to move.

Don't expect to sell everything you take to a gun show. Whatever you bring back can be returned or kept for next week's show, depending on the wishes of the consignee. Also, if interest is shown in a piece but the price is too high, any price reduction is up to the consignee.

All the above is called "operating on a shoestring", where you have little cash outlay. As you learn guns, their pricing and how to work gun shows, you'll be ready to go into bigger operations. But first, get this grounding in a professional career which virtually has no limits.

Open Seams in Boats

The Amateur Mechanic, 1920

AFTER a boat has been hauled out of the water for the winter the planking is liable to dry up and consequently shrink so much that when the boat is launched at the beginning of the next season considerable leakage takes place, damaging the paint work and causing much annoyance and labour. This may be avoided by coating the outside of the planking of the underwater portions with raw linseed oil, soon after the boat has been hauled out. This prevents, to a great extent, the evaporation of the moisture present in the wood, and minimises the amount of shrinkage.

It sometimes happens that, from various causes, the planking of a boat shrinks so much that daylight can be seen through the seams. Should the trouble have been caused by the rotting of the caulking material, re-caulking will, of course, be necessary. It may have been the result of using green (or unseasoned) wood for the planking, but the remedy is the same—re-caulking. But, in general, it is desirable to be very careful about re-caulking seams which are open merely as the result of the wood being very dry, as many a boat has been ruined through being caulked so tightly that no room was left for the swelling of the planking, with the result that the planking burst away from, or broke the timbers. In such a case the best thing is to fill the seams with common soap just before launching the boat. This will prevent much water from getting in, but will be squeezed out as the planks swell up again and the edges come together.

THE COMING MASS INSANITY IN AMERICA

by Kurt Saxon

Millions of Americans today are potential murderous psychotics. The recent uproar over health care in the U.S. was not so much to keep Granny breathing in and out for a few more years. Or to keep Gramps fit to fish. The big issue; the unstated issue, is the real fear that costly prescription narcotic tranquilizers will soon be unaffordable to millions who must have them or go berserk and turn town after town into a nightmare of carnage as happened in Kileen, Texas.

Soon, Granny will take a butcher knife to Gramps, then go across the street and carve up her 80 year-old best friend whom she suspects is seducing him. Joe, the retired accountant, will load up his .44, go down to the bank and do a Clint Eastwood on his still-working associates who plotted his early retirement.

All levels of society will be affected. Millions of Americans spend hundreds of dollars each month on tranquilizers. These aren't just to keep stressed housewives from screaming at the kids, as is commonly believed. They are, more and more, keeping your happy-go-lucky neighbor from going stark raving mad.

In 1964 I got work as an attendant "aide" in the Arizona State Hospital, or nuthouse. I soon noticed that the chargeaides, those running the wards, were mostly beefy, rough types, unlike us new aides who were of average build. The reason for this was that brains, not brawn was the new style in aides since the recent introduction of tranquilizers.

Before the tranquilizers, brute force was needed, as the main medication was peraldehyde, a strong narcotic which made the patient too groggy to function. But with real tranquilizers, the average patient could be stabilized and soon even released, with his own tranquilizers so that he could function normally on the outside.

For a short time I was posted on the violent ward. Most of the patients there appeared normal but were under sentence so could not be released. One couldn't tell them from outsiders without looking at their charts. But before they were put on tranquilizers, they were psychotic killers, guilty of the most hideous crimes.

As I worked on the various wards I noticed the tranquilizers were taking on a major role in mental health care. They were used for everything from a neurotic twitch to a psychotic episode. And more people were being released who, if they lapsed in their self-medication, could be dangerous.

Remember, that was way back in 1964.

Since then the incidence of mental illness has increased tenfold. There are about 40 million prescriptions written for tranquilizers each month. Many, like Valium and Qualudes, are actual narcotics, the lack of which can bring on psychotic episodes as well as withdrawal symptoms as serious as withdrawing from heroin. They have been sold by pushers and people have killed to fill their need for them.

There will be more cutbacks in health care, along with the price-rise of the more expensive tranquilizers. More of the presently stabilized will destabilize as they become unable to get them free or find the price rise too much to afford. And what of those users who are laid off? The mild-mannered office executive with nothing to do but brood is capable of anything. White-collar outbursts have so far been isolated cases and have been attributed to other causes. But as they grow in frequency they will include greater numbers of unsuspecting victims.

Killings due to running out of tranquilizers have so far been limited to blue-collar types. Just plain folks. The massacres in Modesto, Little Rock, at McDonalds and in Kileen, Texas were committed by unemployed psychos who had probably run out of their medications. The Kileen, Texas wipeout artist is rumored to have been on Prozac. Angered at having lost his job and perhaps being unable to afford an expensive prescription, he was primed for slaughter. The pattern has been repeating itself increasingly in the past few years.

The reason is simply waves of depression combined with overpowering rage, brought on by the lack of tranquilizers, which made a mentally ill person seem relatively normal. Most such people don't know their true condition or understand what's coming over them as wave after wave of depression and then rage possesses them. Each feels everyone is against him so he's going to end it all. But first he's going to take as many of the bastards with him as possible.

So millions of Americans are mentally ill and don't know it and hundreds of thousands are actual undiagnosed psychotics. This is due to the fact that therapy has been largely replaced by controlling drugs. The mentally ill are seldom led to an understanding of the fact that their condition is serious. Nor are they committed to an institution where they can be restrained during psychotic episodes. As the illness progresses, even the doctor is fooled, so the patient believes he is only "stressed out", needing more and stronger medications.

So instead of a psychiatrist recognizing a neurotic becoming a potentially dangerous psychotic, an M.D. simply prescribes more Valium. We've seen the sensational results of lapses in medication of undiagnosed psychotics. It's still big news. But it will be a common occurrence soon.

Mental illness has many causes. It can be hereditary but is more often caused by traumas, or shocks to the nervous system, which can leave permanent damage in certain areas of the brain. It's pretty common knowledge that food additives cause certain children to become hyper-active and otherwise demonstrate abnormality. It stands to reason that adults are likewise affected. I saw a close friend go progressively insane from caffeine as he drank from three to five two-liter bottles of cola each day. Then there's pollution of the air and water, etc.

You could be going mad through no fault of your own, and not even know it. A twitch here, an anxiety attack there, flashes of rage, paranoia, the world closing in. Next thing you know a doctor is prescribing a dangerous, addictive narcotic to "settle your nerves". As time goes on, you need more to relieve your condition. Either you need more because your condition is growing worse or your body is developing a tolerance to the drug and the nervousness you feel is not the initial problem, but legal drug addiction.

I experienced this after two and a half years on Valium. I couldn't sleep. I was more nervous than ever, became enraged when there was no one to be angry at and realized I'd have to increase my dosage or go mad. But I needed a clear mind to write and so couldn't give in to a higher dosage and a fogged brain.

Knowing common, non-narcotic medicinal herbs had been used for nervous disorders for hundreds of years, I looked through my old herb books to find a substitute for Valium. I first noted all my symptoms, which I felt in periods when the Valium was wearing off. These were depression, anxiety, anger and panic. I looked up the symptoms and then noted the herbs prescribed for them. Hops, valerian, scullcap and camomile, in combination, treated them all.

I brewed up some tea and, lo and behold, needed no Valium from that day on. I had also been a heavy drinker but found I soon lost my desire for booze.

I went cold-turkey with the Valium and suffered withdrawal symptoms for six months. I believe the herbs made them bearable. Regardless, kicking any narcotic is rough, but easier in the long run than staying hooked.

If you think you'd just rather stay on your

prescribed poison, consider. The longer you're on it, the harder it is to kick. But soon you may no longer be able to afford it or it may not be available at any price. You'd best switch to something more affordable and which you can stock up on.

Stocking up is a very important consideration. You must realize you can't buy a year's supply of Valium or any other prescription drug. And of course, buying a year's supply of dried herbs for making tea would be very expensive and the dry herbs would lose their potency as they are loosely packaged and not air-tight.

But, if you buy powdered herbs or powder them yourself, they will keep indefinitely if stored airtight. A good place to buy hops, valerian, scullcap and camomile, if your health food store doesn't stock them powdered, is the Penn Herb Co. (as of 1999 1-215-632-6336). Call and ask for their catalog. Also consider growing them.

Mix the herbs in equal proportions. To use, take a heaping teaspoonful. Don't breathe in or out. Wash it down with a liquid. Within a few minutes you will feel better. If one dose isn't enough, take another in half an hour. For about two days it may make you drowsy or give you the runs. This is temporary.

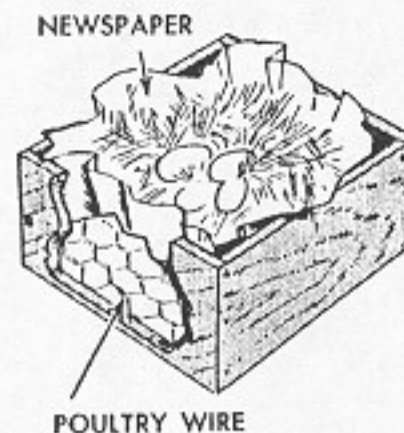
These herbs have been tested and proven for nervous disorders for hundreds of years. This compound has already proven itself better than Valium, Prozac, Halcyon, Buspar and several other prescription tranquilizers. It also eliminates premenstrual syndrome, tension headaches and various other ailments not necessarily associated with any sort of mental illness.

Popular Mechanics 1947

Hens' Nests With Wire Bottoms Are Easy to Clean

Sanitary nests for hens are easy to make by simply constructing wooden frames and fitting them with bottoms of poultry wire. Covering the wire with old newspapers keeps the nesting material from falling through the wire. To clean the nests, simply dump out the paper and nesting material and replace it. The wire provides no corners or crevices for vermin.

Jack Bronte, Grass Valley, Calif.





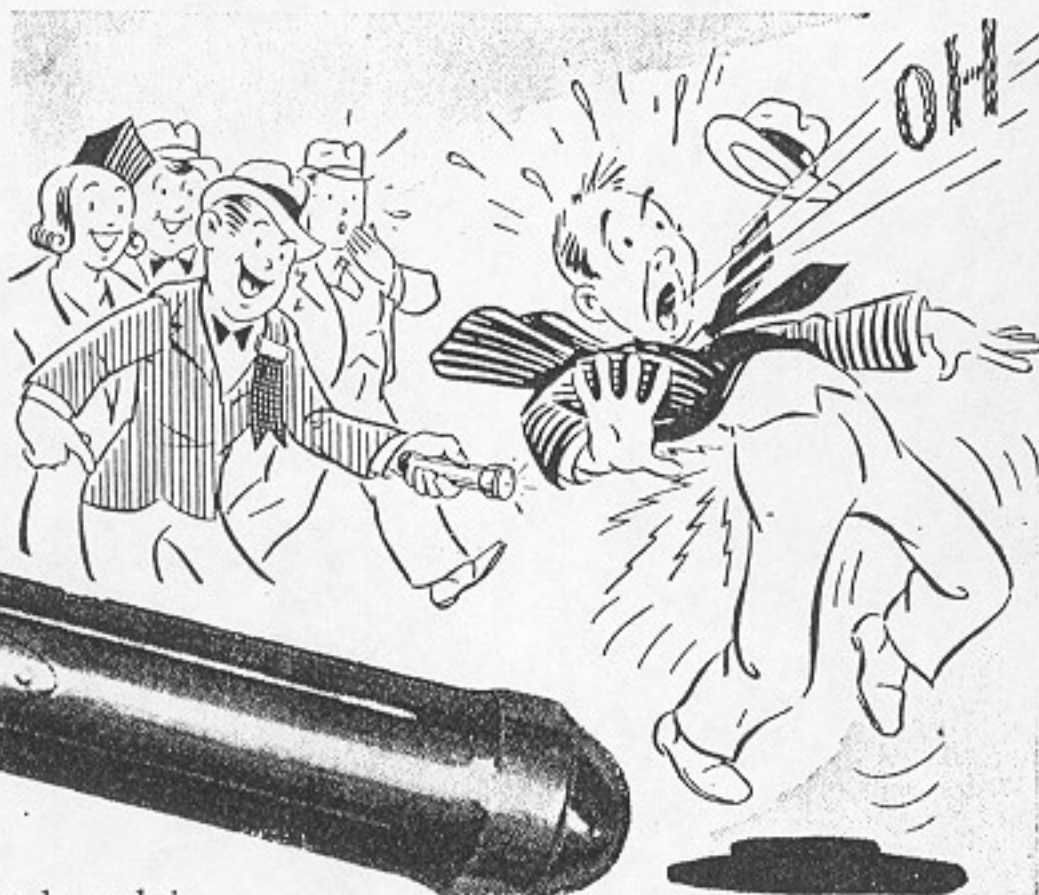
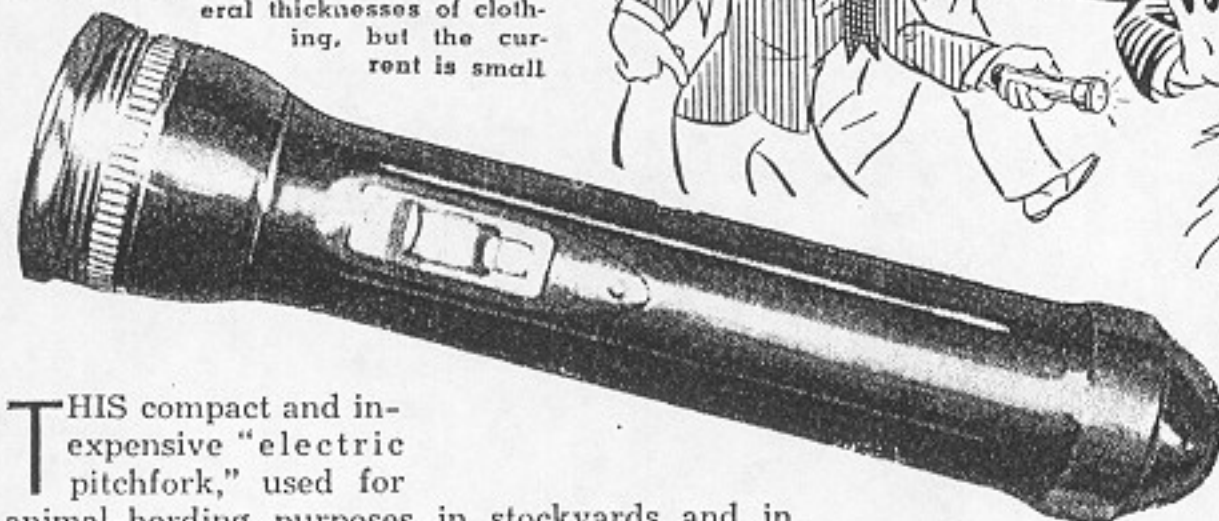
CHARLES G. ROGERS, Editor

SCIENCE AND MECHANICS JULY—AUGUST, 1940

Want a Flashlight "Shocker?"

By L. J. MARKUS

Two flashlight cells and a tiny model airplane ignition coil convert this ordinary three-cell flashlight into an "electrical pitchfork" which can bring worlds of fun and laughter at carnivals, parties and fraternity initiations. Just hold the lens end of the flashlight lightly against a person and press the button. The voltage pulse produced is of the order of 10,000 volts, which is high enough to be felt through several thicknesses of clothing, but the current is small.



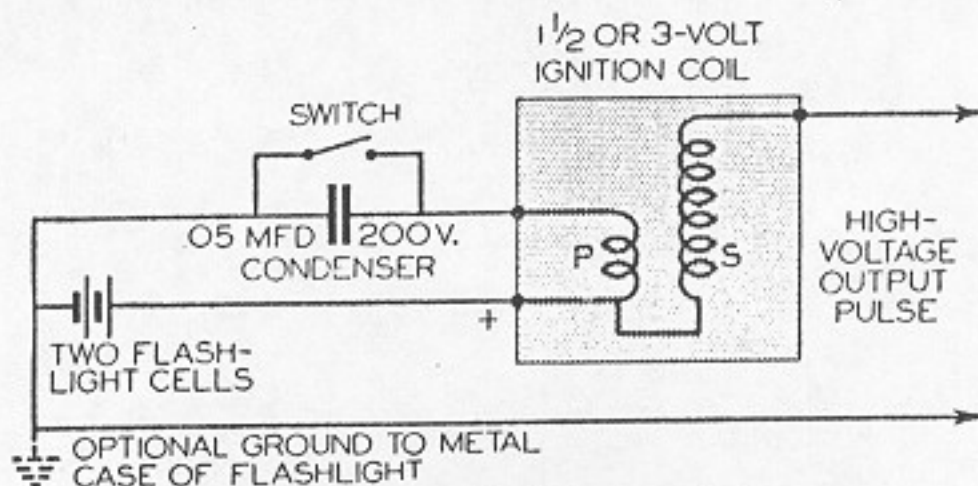
THIS compact and inexpensive "electric pitchfork," used for animal-herding purposes in stockyards and in cattle country, is primarily designed for entertainment purposes, but has a host of practical uses as well.

Even the stubbornest of mules will forget his natural contrariness and "giddap" when this innocent-looking flashlight is pressed against an appropriate spot on his hide. Likewise, when commands to other animals are followed by shocks, disobedience will miraculously disappear.

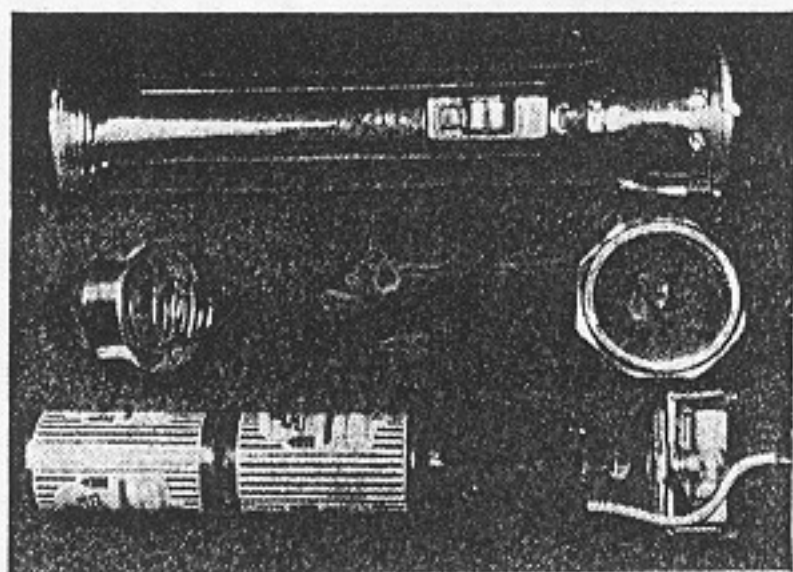
An electric shocker is thus a valuable and humane aid in training animals of all kinds.

The "business end" of the shocker can easily be extended by means of a fishpole when necessary (this is recommended in the case of mules, where the first reaction will very likely be made with both hind feet). The flashlight can be taped to the butt end of the pole, and two wires taped to opposite sides for the length of the pole. One wire is connected to the flashlight case, the other to the high tension lead in the center of the lens. The wires must be at least one-quarter inch apart at all points, and the far ends must be bare.

Wherever fun and frolic is the keynote of the day, as at convention parades, New Year's Eve celebrations, initiations and Hallowe'en parties, this electric pitchfork can enliven things considerably. It is recommended, however, that a body-guard be kept within call just in case



Basic circuit of the flashlight-case shocker.



All parts used in the flashlight-case shocker are shown here.

some husky chap resents the upsetting of his dignity. In emergencies, however, the flashlight can be applied to the bare skin of a belligerent with amazingly improved results.

Few Parts Are Needed

An inexpensive three-cell flashlight, two flashlight cells, a .05 mfd. condenser and a midget ignition coil of the type made for model airplane gas engines are the only essential parts needed.

Either a 1½-volt or 3-volt coil can be used, provided it can be made to fit into the space of one flashlight cell. Two cells should be used in either case, however, to get sufficient voltage to penetrate thicknesses of cloth or fur.

Study the basic circuit carefully before buying the flashlight, so you can select one which will require a minimum of modification. The ideal type is one having a pushbutton switch in addition to the slide switch, but these are a bit difficult to obtain. Flashlights made especially for Boy Scouts have this feature, however, to permit night signalling by blinking the light off and on.

One shock is produced at the instant of closing the circuit, and another when the circuit is opened, for an ignition coil responds only to changes in current. Battery energy is being wasted when the switch is on, hence a pushbutton switch keeps battery drain at a minimum.

Modifying the Coil

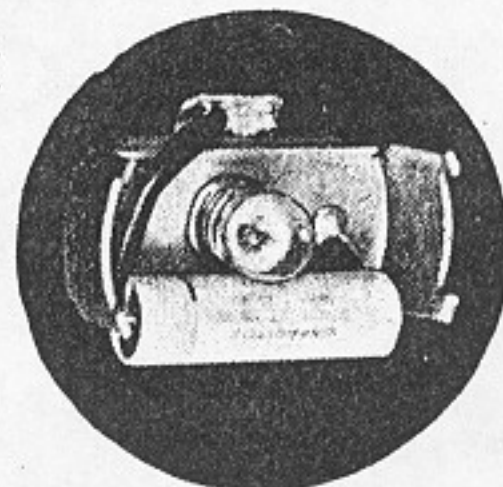
As the circuit diagram shows, the two primary terminals of the coil are connected into the circuit exactly as would be the third cell of the flashlight. Now, if we extend the coil primary terminals until they are in the same position as flashlight cell terminals, the primary coil connections will be made automatically when the coil is placed in the flashlight case.

First of all, the pencil-shaped mounting studs were cut down slightly so as to make the coil the proper length. The iron core inside these studs can be cut a small amount if necessary, but cover the exposed ends with sealing wax before proceeding further. Now run a narrow strip of sheet copper from the + Fahenstock clip to the



When the ignition coil is modified as shown here, it fits into the space normally occupied by the flashlight cell nearest the lens.

Method of connecting the condenser.



nearest stud, bend the strip over the stud, wind bare copper wire around to hold it in position, then apply solder to the wire. This end of the coil

should rest on the center (+) terminal of a cell.

From the other Fahenstock clip, run insulated wire to the other stud, and solder it to a short copper strip bent over the end of the stud. This end of the coil will contact the button underneath the bulb holder.

The coil used for this project originally had a snap button on one side for the high tension lead. This was cut off. The insulating tubing surrounding the coil was then slid off far enough so the high-tension wire supplied with the coil could be pushed under the tubing from the bulb end and made to contact the flexible braided secondary coil lead. The housing was then pushed back, and the former terminal hole filled with sealing wax.

Condenser Connection

The .05 mfd. condenser can be placed alongside the bulb socket if the reflector is removed. This condenser is connected across the switch in the unit pictured. This was done simply by soldering one lead to the bulb bracket and the other to the bulb terminal going to the switch. The socket terminals must be shorted; this can be done most easily by taking an old bulb and shorting the threads to the tip terminal with a drop of solder, then screwing the bulb into the socket.

Since this coil can send a spark across a quarter-inch gap, insulation around the high tension lead must be adequate to prevent leakage inside the case. The critical point is that where the high tension lead enters the coil, so several thicknesses of sheet mica should be placed between the coil and the case at this point. The mica can be obtained from an old mica condenser, and can either be glued in position or tied with strong silk thread. It will make the coil fit tightly.

A hole should be drilled in the center of the glass window or lens, through which you can push the bare end of the high tension lead after cutting it to the correct length. You can make

this hole with an ordinary metal drill about 1/16" in diameter, if you apply turpentine liberally during the drilling. Rock the drill sidewise while drilling. Practice first on a scrap piece of glass.

It is a good idea to try out your circuit outside the flashlight case, to see how long a spark can be obtained between sharp points. If this same spark is not produced by the completed unit, there is leakage inside the case, and more mica insulation will be required. If a flashlight having a fiber or plastic case is employed, insulation problems will be simplified.

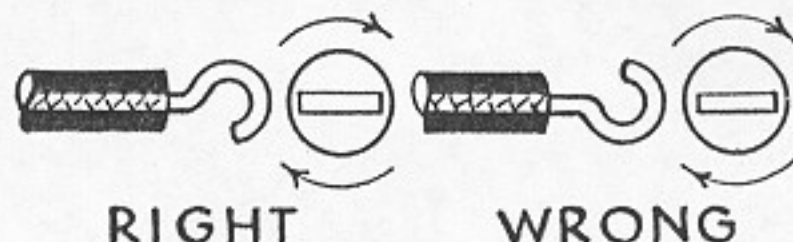
Once you are familiar with the basic circuit, you can readily devise means for making the proper connections regardless of the type of flashlight employed. Of course, any other type of housing arrangement can be used in place of the flashlight case, as long as circuit connections are correctly made.

Handmade Terminals

THESE sketches show a practical kink well known to journeyman electricians. When the wire is bent in the wrong direction to form a terminal, tightening the binding screw tends to

force the wire away from under the screw head. This will cause trouble later when least expected. Always form the loop around the screw to the right, or clockwise.

There is another point to be remembered in

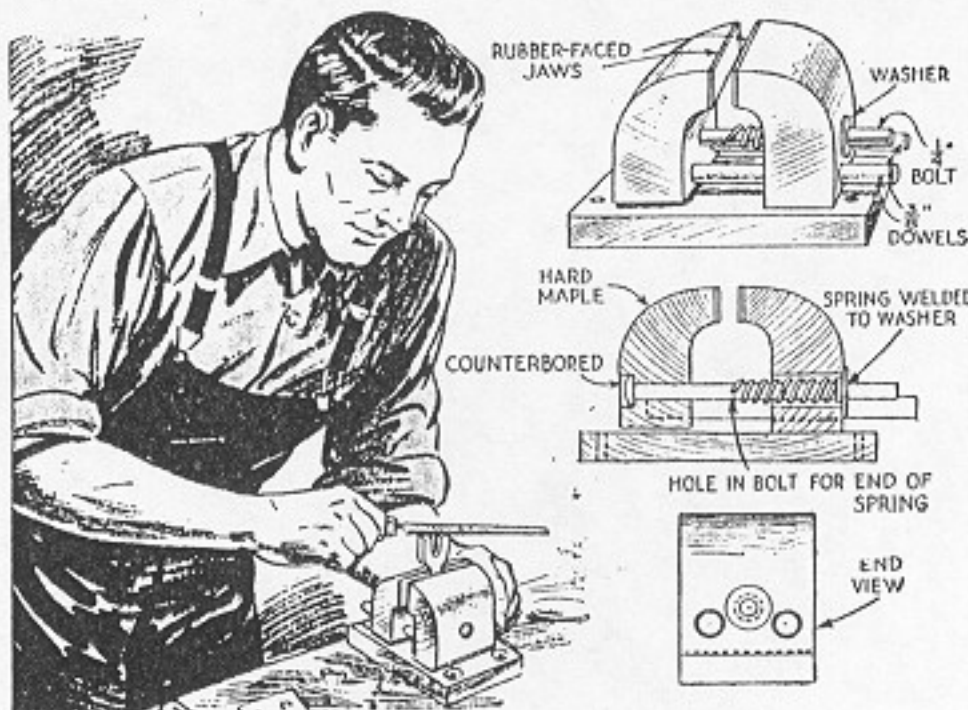


forming a terminal on the end of flexible cord or cable. After removing the insulation, the average right-handed person twists the exposed wire to the right to tighten the strands together. Not all stranded wire is twisted to the right in manufacturing, however, and left-twisted wire should be twisted to the left. If flexible wires are not treated properly as described, a weak spot will be left just inside the end of the insulation.

When possible, the separate strands of a cable should be bound together by tinning the stripped and bent end before fastening it.

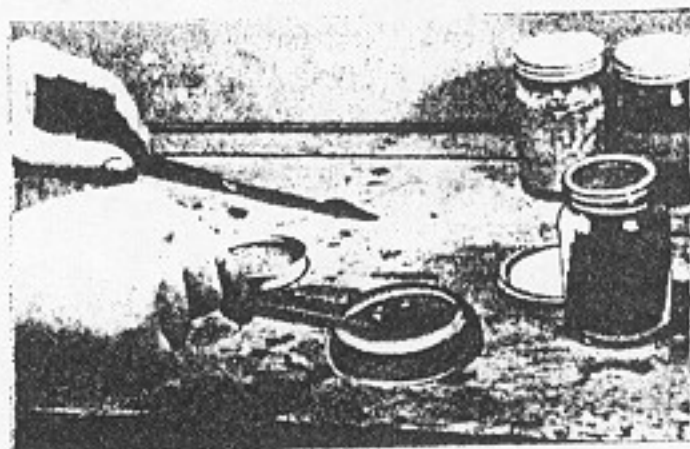
POPULAR MECHANICS December, 1940

Small Spring-Operated Vise for Modelmakers



Handy for many small jobs done by the model-maker, this simple little spring vise is easy to make. Hard maple is used for the jaws and base, and 3/8-in. dowels for the slides. A 1/4-in. bolt with a spring and washer over it provides the compression. A handle may be added if desired. Larger vises with stronger springs can be used for heavier work, the base being bolted to the bench top.—Paul H. Smith, Norfolk, Mass.

Powdered Colors Are Handy to Match Paints for Small Touch-Up Jobs



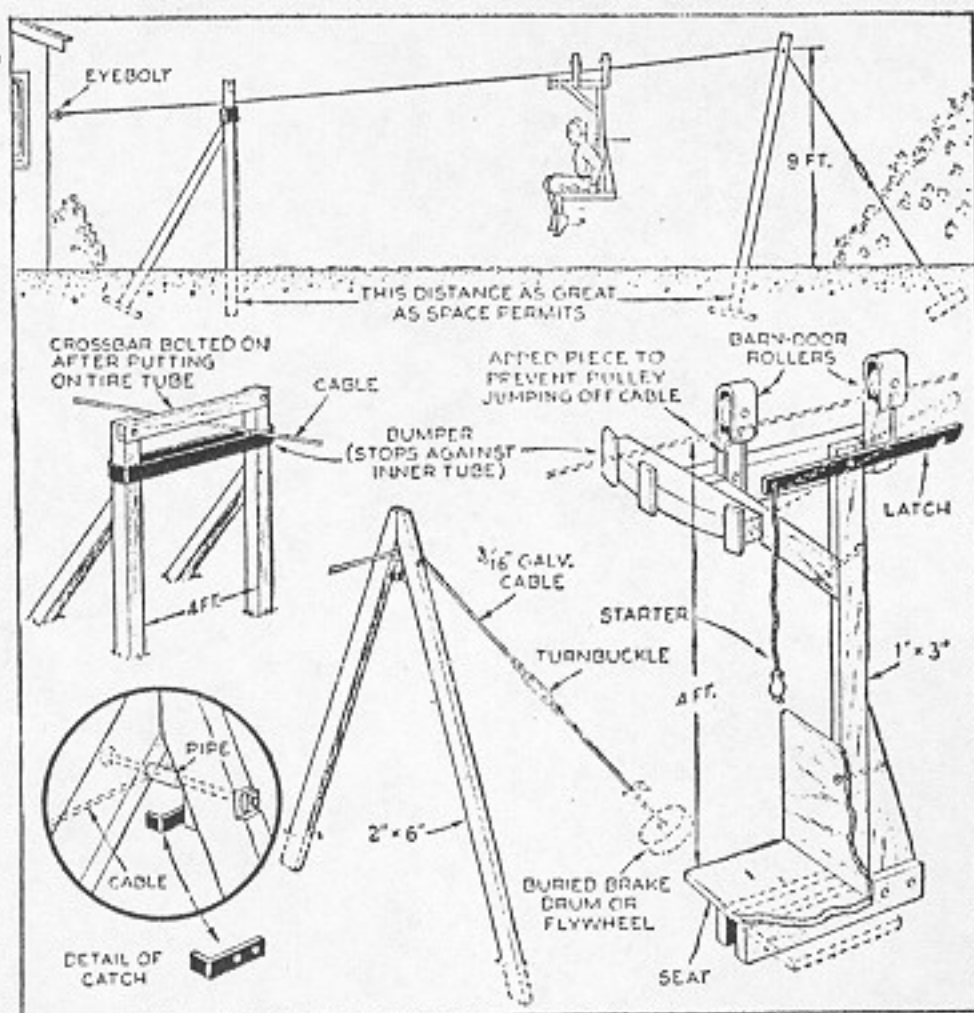
A variety of powdered colors that can be obtained inexpensively from art dealers is handy to have in your workshop for matching paints for small touch-up jobs. When a painted article has to be matched, select the paint that most nearly matches it and add to it a little powdered pigment of the desired color.

☞ To give added gloss to reed furniture, dip a stiff brush in furniture polish and brush the furniture well.



BACK-YARD Aerial Glide PROVIDES THRILLS

SLIDING down a wire has always held a fascination for small boys, and here is a device that gives a thrilling ride of this kind with perfect safety. A galvanized cable is stretched from a garage or other structure to an inverted V-shaped frame and made taut with a stout turnbuckle. The end is anchored to a buried brake drum or other piece



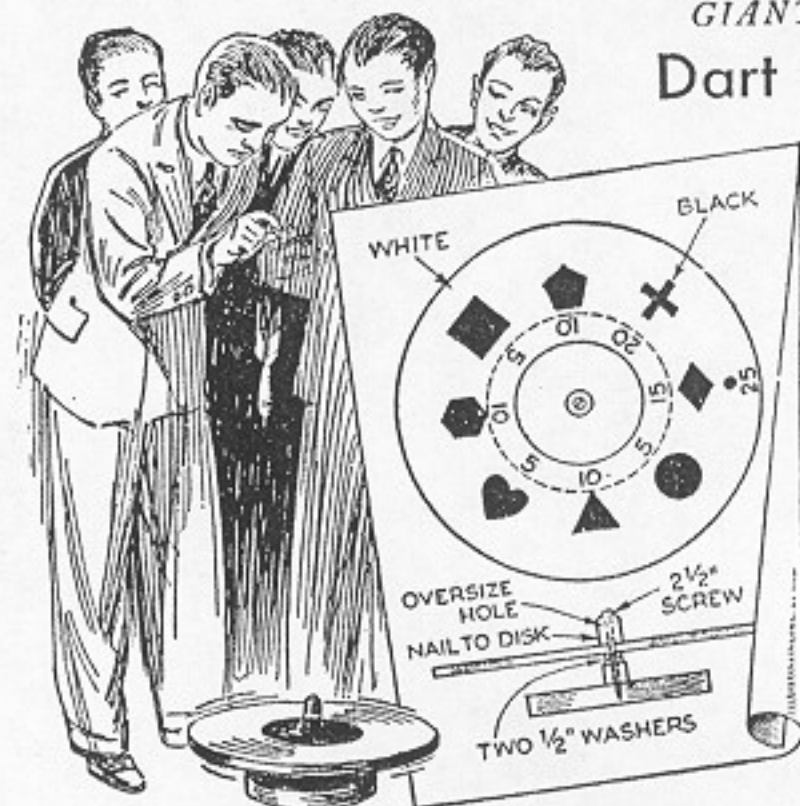
How the glide is set up. One end of the cable can be attached to the garage if well braced

of junk. Rocks are piled in the hole and loose soil washed in with the hose.

The carriage is hung on two barn-door rollers with a strip of strap iron to prevent jumping off the cable. A wood bumper in front strikes an inner tube stretched over a frame and thus brings the carriage to a gentle stop. Note that the design of the seat permits the passenger to hop off anywhere along the line. A pile of straw could be placed at the foot of the run for the passenger to jump into.

GIANT HOME WORKSHOP MANUAL 1941

Dart "Bombs" Whirling Target



ONLY one dart is used in this new game, called "bomber's luck," and it is dropped on the target, which is a spinning 12" disk of fiber wall board placed on the floor. Eight designs are painted on the disk as shown, and it is mounted on a block so that it will turn freely.

Whirl the disk with the knob—not too fast—and hold the dart to the tip of the nose while standing erect. Then let go before the disk stops. Each player has three chances, and after five rounds the score is added to decide the game. If the dart sticks inside the inner circle, which is 4" in diameter, another shot is allowed. A suitable dart can be bought, salvaged from another dart game, or made, as preferred. The point should be very sharp.

Fresh Vegetable and Fruit Dehydrator for Victory Gardens

AERICAN soldiers, sailors, and marines, and all their auxiliary forces, are now eating dehydrated foods on all the battlefronts of the world. Is there any reason why the folks who remain at home should not also eat dehydrated food, especially next winter when a hungry world will be even hungrier than it is now? There is no reason. Any other answer would be un-American, to say the least.

More than 28,000,000 Victory gardens has been set as a quota for the American people this summer. Nor is it too much to say that dehydrated food could be prepared from every one of those gardens if dehydrating equipment were available.

As a matter of fact, it is available and at very low cost to any gardener who is skilful enough to put together a few pieces of lumber, glass, fiberboard, an electric fan, a thermometer, five lamp bulbs, some wire, and a few nails.

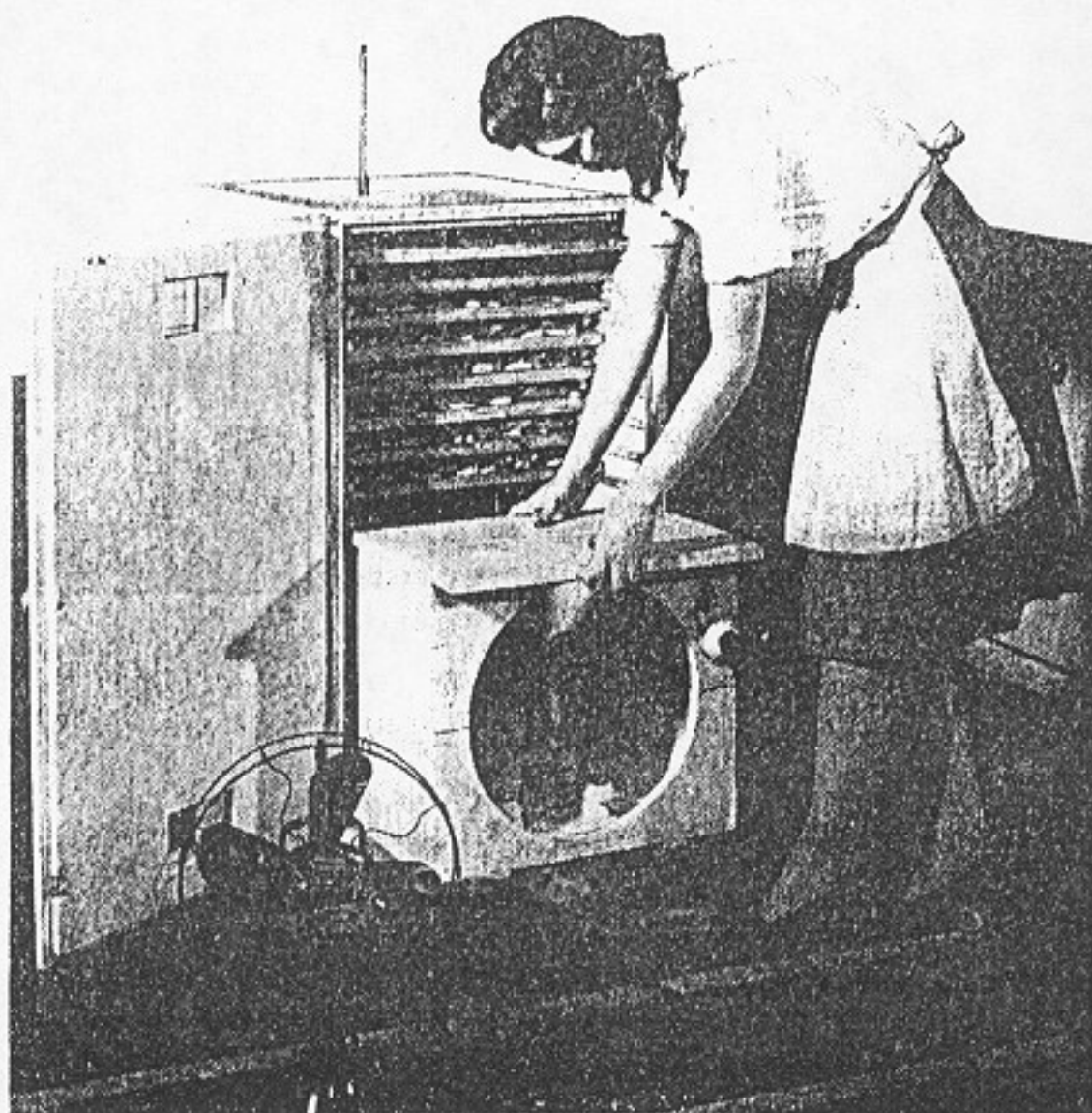
New and easy-to-build types of dehydration equipment have been developed by the Tennessee Valley Authority and the University of Tennessee. These models are offered as a means of saving vital tons of steel normally used in canning operations and to plug the holes in America's restricted wartime meals. Several manufacturers are studying the new model dehydrators, but as yet commercial production has not been authorized. There is nothing, however, to prevent any man taking the plans and building a dehydrator for his own use.

A primary consideration in the development of the models shown to date has been to hold the costs of the dehydrator to a point within the means of the average family. Materials for constructing any one of the several "kitchen" models cost approximately \$10, not counting the electric

At a cost of not more than \$10 for materials, you may build a kitchen model dehydrator with a fresh weight capacity of 10 to 25 pounds.

Designed by Agricultural Experiment Station
The University of Tennessee

SCIENCE AND MECHANICS SUMMER, 1943



America's fighting men are eating dehydrated food on all battlefronts. Folks who stay at home must eat it too, and like it, next winter.

fan which can be a standard 10" or 12" household fan. All of the models are constructed largely of non-essential materials.

Plans for one of the models, for use with a pedestal electric fan and with a capacity of 10 to 25 pounds of fresh weight, are shown on these pages. The dehydrator stands 39" high, and on a base 26¼" deep by 21¾" wide. Five 200-watt electric lamps are required.

Two larger dehydrators have also been developed. One is a porch unit with a capacity of

about a bushel of food for large families, and a community dehydrator with a capacity of about fifty bushels. The porch type is about 4 feet long, 2 feet wide, and 36 inches high. The community type is designed to fit into existing community canning plants where preparation equipment and steam boilers are already available.

To make the dehydrator here shown, do this:

1. Make side, top, bottom, back, and door frames. Use corrugated fasteners to assemble

butted joints and nails for overlapping joints. Be sure to maintain inside dimensions, if varying width lumber is used.

2. Assemble top, bottom, and side frames. Tack on temporary corner braces at front to hold box square.

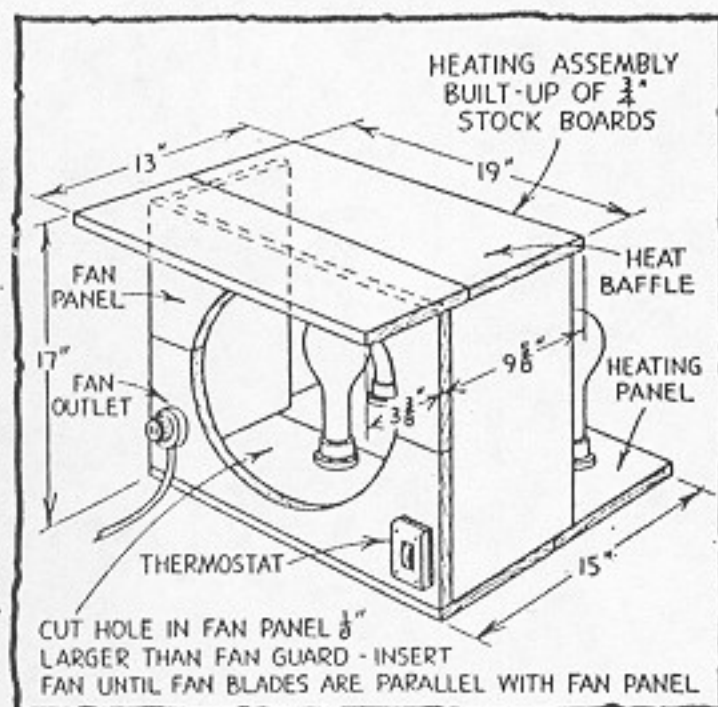
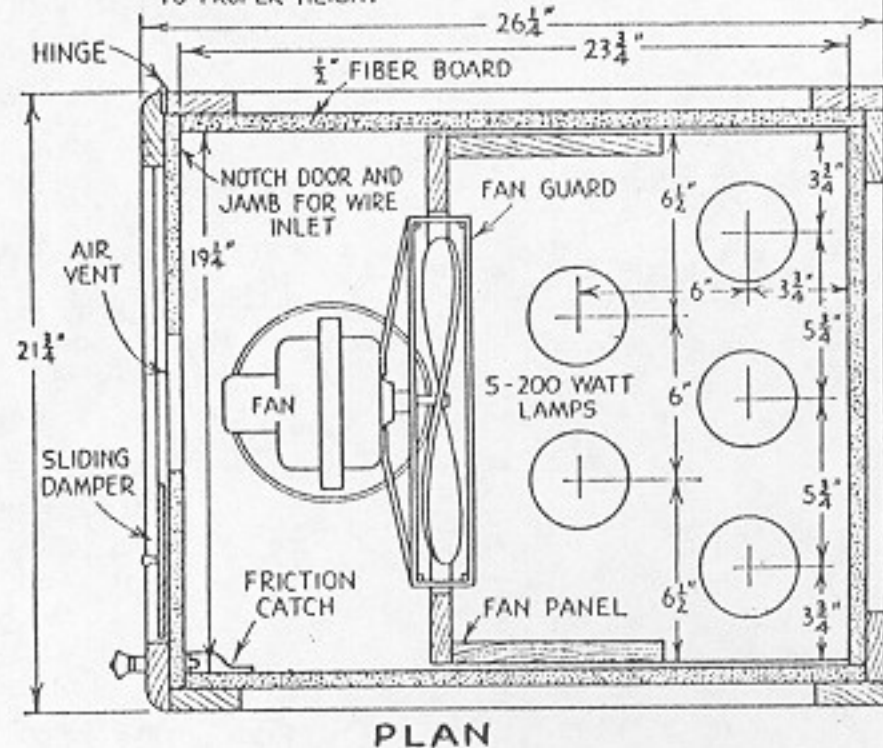
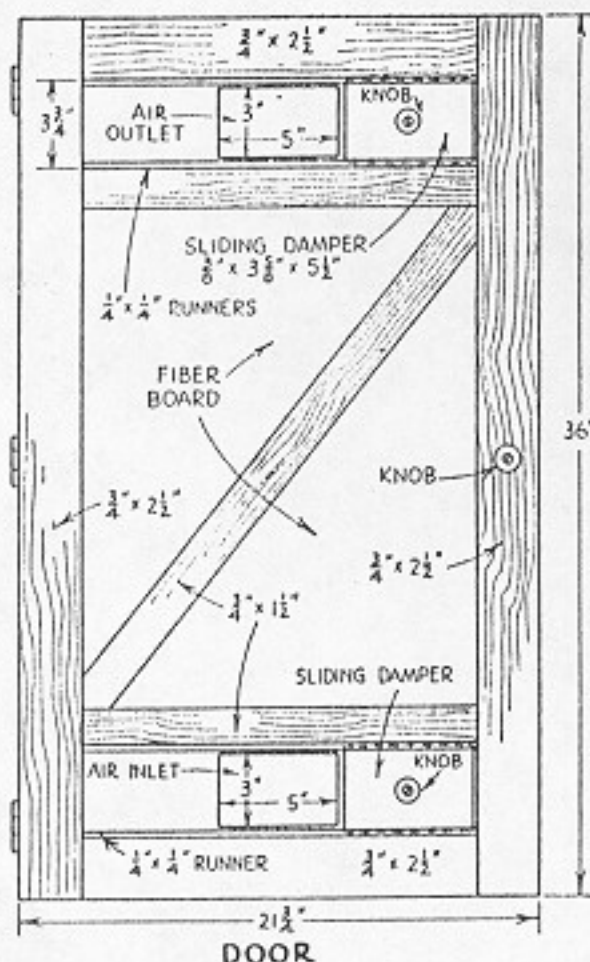
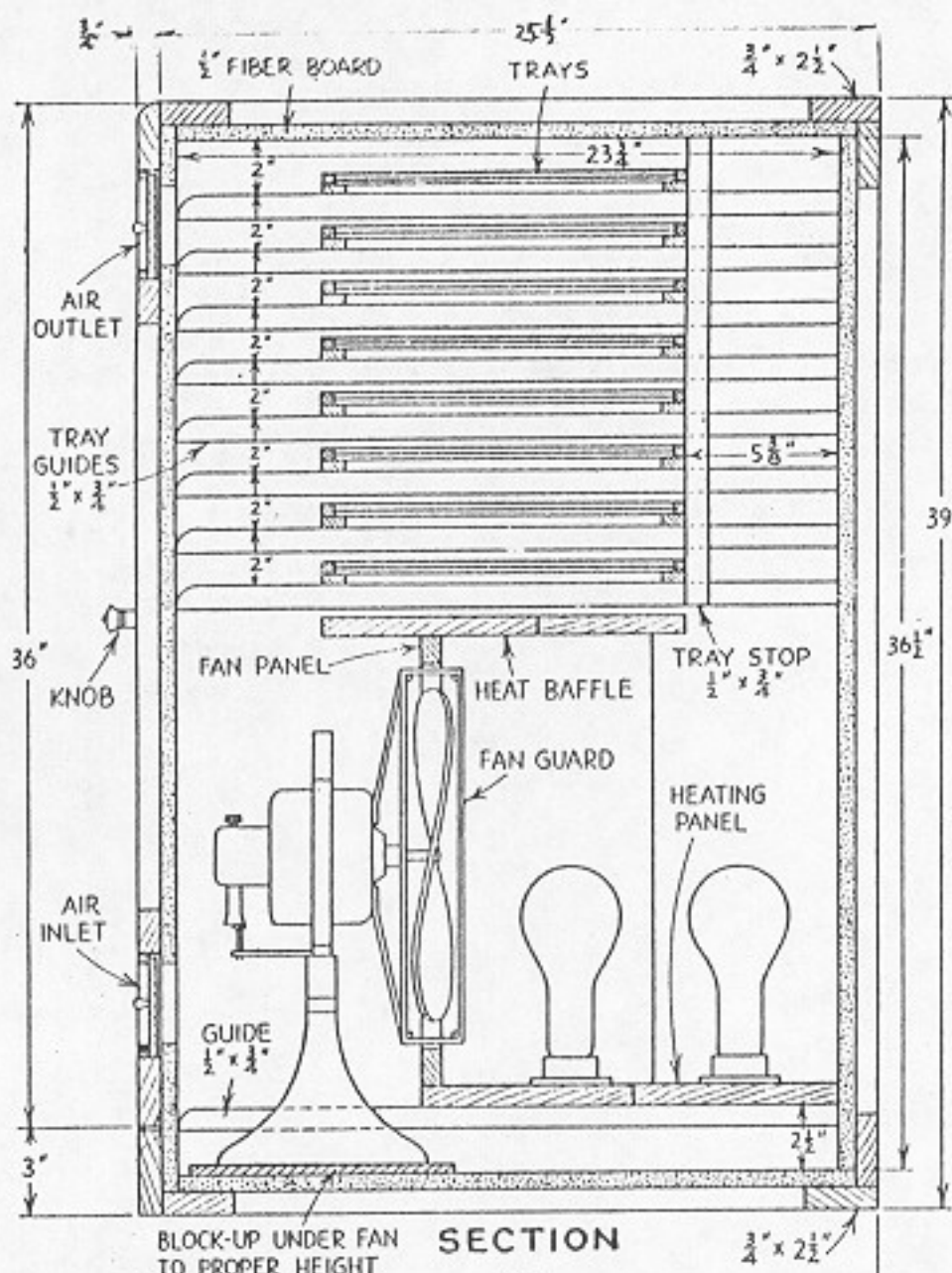
3. Check frame dimensions and saw fiber-board panels to fit, using the layout plan shown as a guide. Install panels in frames and nail with large head galvanized nails.

4. Trim back to fit snugly and fasten in place.

5. Remove corner braces and install guides.

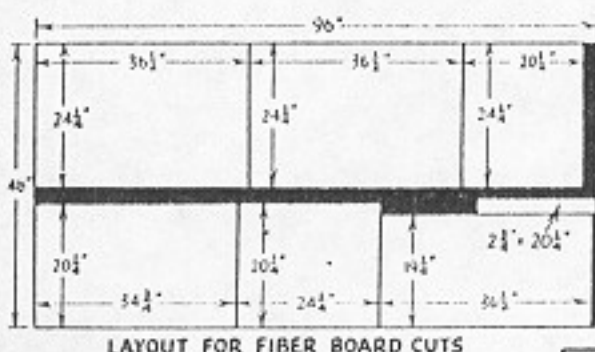
6. Assemble and hang door. Be sure it swings smoothly.

7. Assemble removable heating



unit. Cut hole in fan panel to fit snugly over fan guard of either a 10" or a 12" fan. Maintain 1" dimension between bottom of fan guard and heating panel for either fan.

Do not let the bulbs, or heating elements, shine directly on the thermostat or thermometer. The thermostat may be omitted. Heat is then controlled by unscrewing bulbs as needed to keep the temperature from getting too high. A good ther-



thermometer with a range in excess of 180 degrees F. must be provided. It can be inserted in a hole through the top of the cabinet or laid on a tray. If a box is used for sulphuring, be sure to remove the heating assembly and fan during treatment. A bracket fan may be used.

Vegetables considered particularly suitable for dehydration include: lima beans and green snap beans, carrots, cabbage, sweet corn, okra, green peas, Irish potatoes, pumpkin, soybeans, sweet-potatoes, and turnip and other greens. Fruits include: apples, figs, pears, and peaches.

Proper treatment of the foods prior to the actual dehydration is an important phase of the processing. Extensive tests have demonstrated that blanching vegetables and sulphuring fruits improve taste, appearance and preservative qualities of many of these fruits and vegetables.

Time required for dehydration varies with several factors; stage of maturity, size of the prepared pieces, thickness at which they are spread on drying trays, and the quantity of products in the dehydrator at any one time. The following table shows approximate times necessary for several fruits and vegetables:

<i>Product</i>	<i>Time</i>
Peaches (not peeled).....	20-24 hours
Peaches (peeled)	15-20 "
Apples	10-15 "
Pears	8-14 "
Beans (green)	10-15 "
Beans (lima)	8-12 "
Corn (green)	7-10 "
Okra	8-12 "
Greens	4-6 "

LIST OF MATERIALS

Part	Pieces	Sizes	Material
Paneling	1	1½" x 48" x 96"	Fiberboard
Frame	1	¾" x 1½" x 8'	Lumber
Frame	6	¾" x 2½" x 10'	Lumber
Frame	1	¾" x 7½" x 10'	Lumber
Heating Assembly	1	¾" x 9½" x 6'	Lumber
Dampers	2	⅜" x 3⅝" x 5½"	Lumber
Damper Runners		¼" x ¼" x 6'	Mould
Tray Guides		½" x ¾" x 48'	Mould
Tray Frames		⅜" x ¾" x 50'	Mould
Tray Frames		½" x ½" x 50'	Mould

(Lumber should be good grade of soft wood and thoroughly kiln dried)

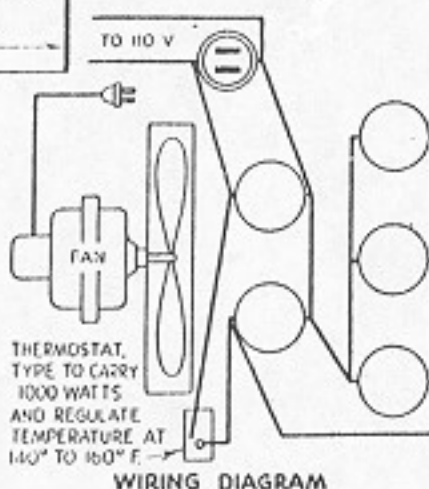
Trays 8 12" x 18" Glass
(Glass should be double strength. If lattice trays are used, add 100
lin. ft. $3\frac{1}{8}$ " x $11\frac{1}{2}$ " and omit the 50 lin. ft. $1\frac{1}{2}$ " x $1\frac{1}{2}$ ")

Electric Fan—1—10" or 12" Thermostat—1 Thermometer—1

Porcelain Sockets—6—with hidden terminals

Lamps—5—200-watt

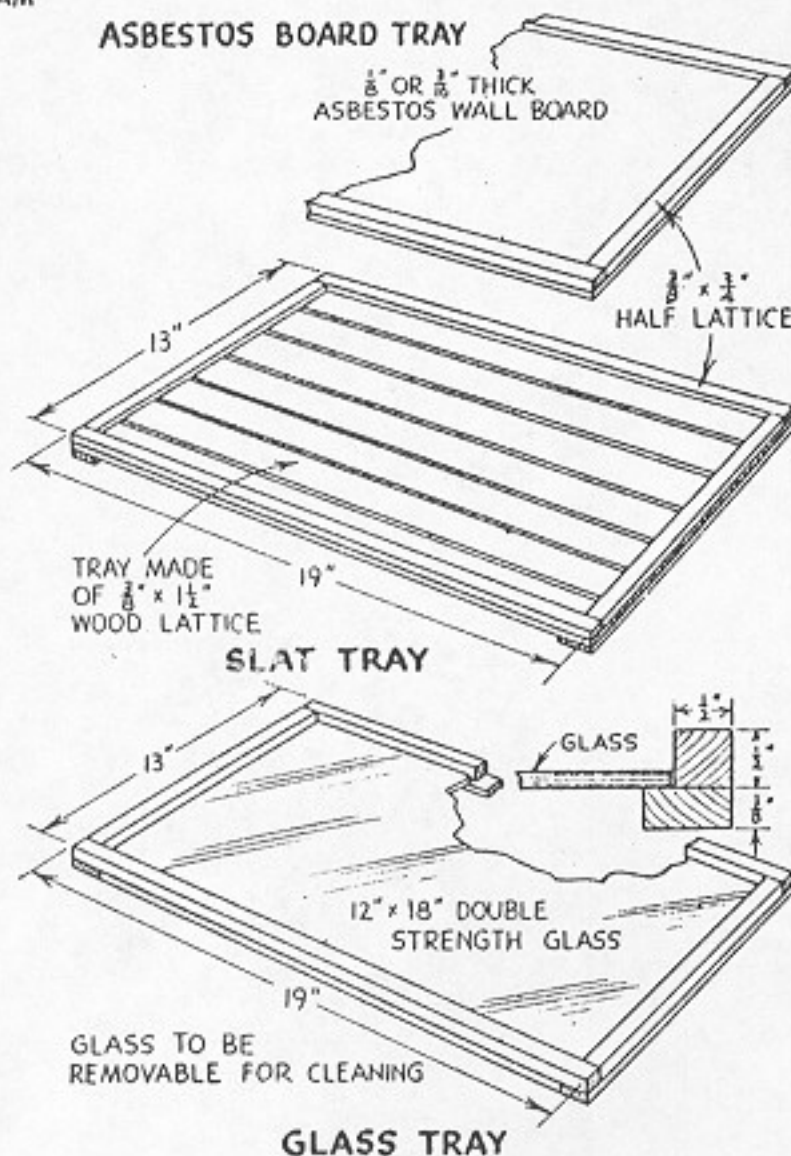
Lamp Wire, Plug, Hinges, Friction Catches, Nails, Corrugated Fasteners



WIRING DIAGRAM

The processed foods may be stored in airtight, moisture-proof bags, lard cans with tight-fitting lids, syrup buckets and similar containers. It is important to keep air, moisture and light away from the finished products and to protect them from insects.

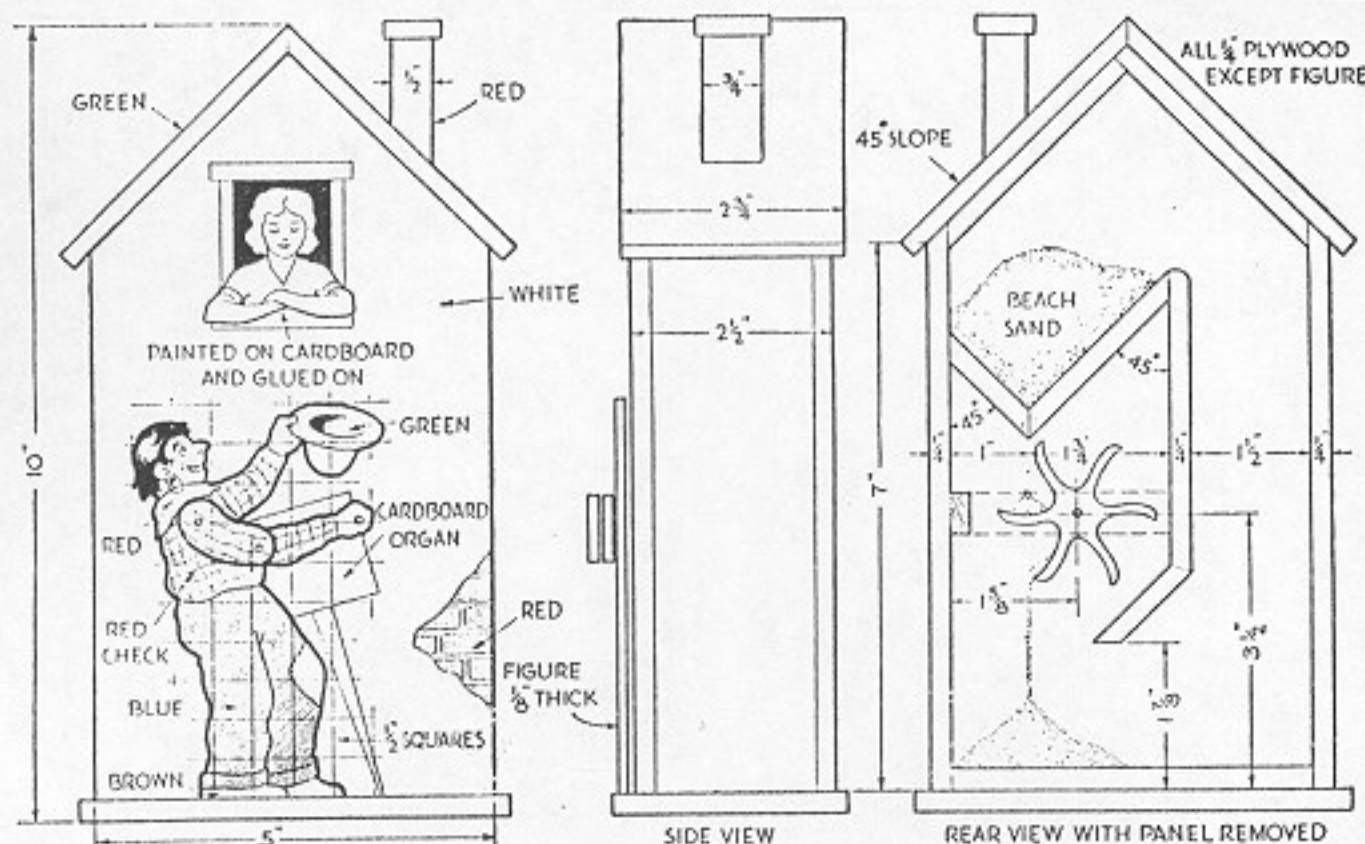
ASBESTOS BOARD TRAY



Sand Motor Drives Organ-Grinder Toy

AN EVERLASTING sand motor provides the power to drive the mechanical organ grinder illustrated. To "wind up" the mechanism, it is necessary merely to give the box a complete turn in the direction indicated in the drawings. This brings the sand back into the hopper ready to run down and turn the small paddle wheel. Other adaptations will suggest themselves, such as a woman pumping water or a hobo sawing wood.

For the box, $\frac{1}{4}$ " plywood is used, the joints being well fitted to prevent leakage of sand. The six-bladed paddle wheel is scroll-sawed from a block of white pine. The axle is a piece of bicycle spoke turning in glass-bead bearings,

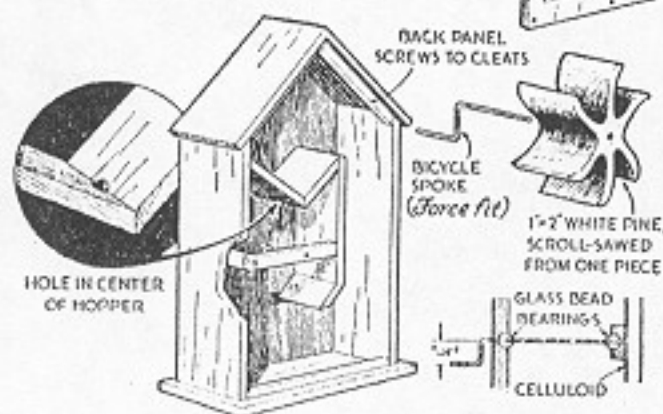


Front, side, and open rear view of the animated organ-grinder toy. The sand motor is "wound" by turning the house sidewise through a complete revolution as shown at left

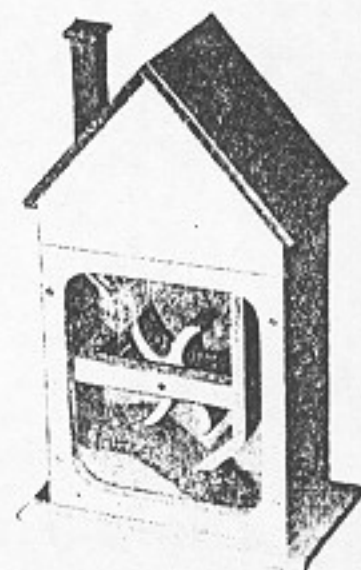
which are recessed into the wood as shown. Short lengths of brass tubing will serve just as well as the beads.

The hole in the sand hopper should not be over $\frac{1}{8}$ " in diameter for beach sand. Incidentally, beach sand is the best because the grains are smooth and pour more readily. Sand from a creek bed is also satisfactory. To facilitate adjustment, the back panel with the window is fastened with No. 3 screws.

The organ grinder is scroll-sawed from $\frac{1}{8}$ " material and painted in bright colors. The girl is painted on cardboard, together with the window frame, and glued to the box, as is the hand organ.



The operating mechanism and a photo of the house with back in place



Mechanics and Handicraft SECTION

Now: Electroplating in Your Own Shop

By John Burroughs

POPULAR SCIENCE NOVEMBER 1962

A bench-top rig you can make puts shiny, lasting metallic finishes on tools and ornaments

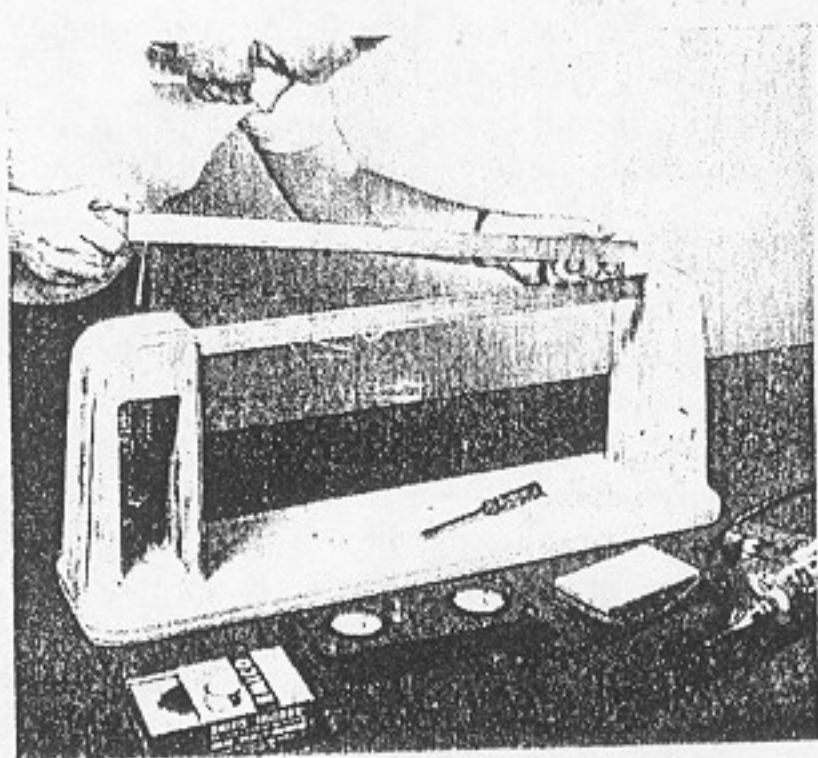
A SIX-VOLT battery charger, a couple of glass fish tanks from the dime store, and a plywood rack to hold two aluminum electrodes will put you in business to explore a fascinating field of metalwork.

Electroplating, the chemical process in which one metal is transferred directly to another, becomes a simple home-shop operation with the setup shown here. With it,

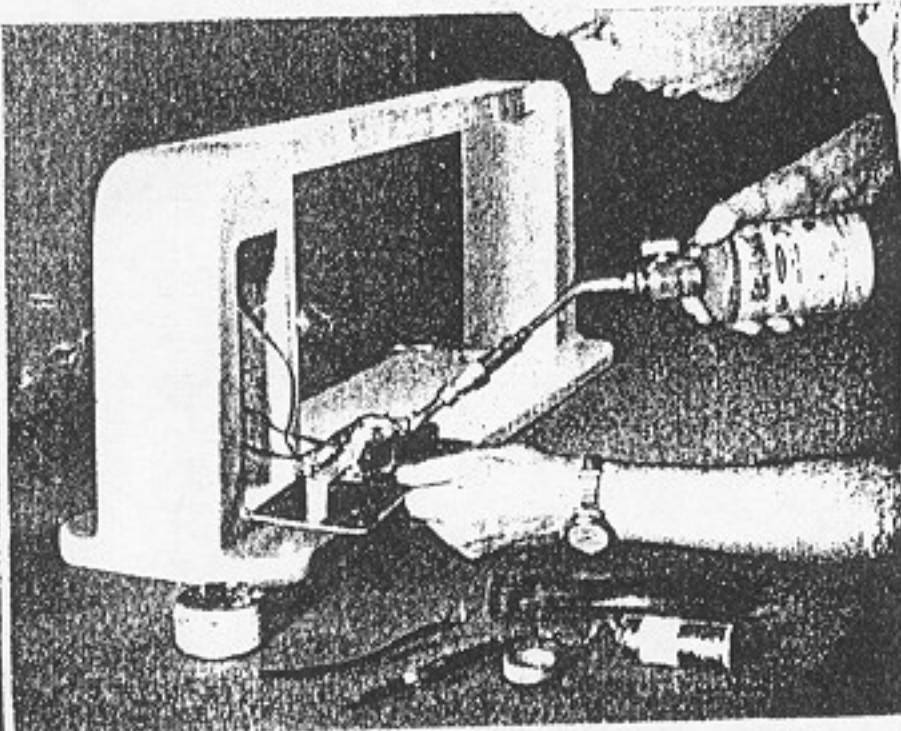
you can put gleaming copper, nickel, or zinc finishes on any iron or steel object that you can dunk in the tanks.

You can rustproof tools, brighten up hardware, even metallize nonmetallic objects like leather, leaves, shells, pine cones, or flowers to make unusual decorations and jewelry. You can electro-etch and inlay designs in copper and brass craftwork. You'll also be able to do electroforming, such as making permanent copper molds for type-metal castings.

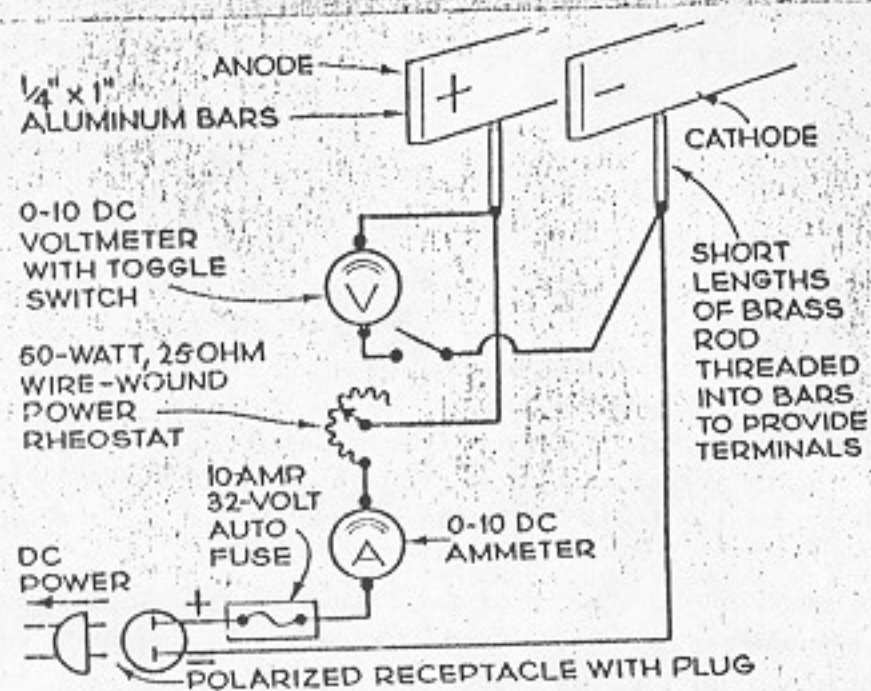
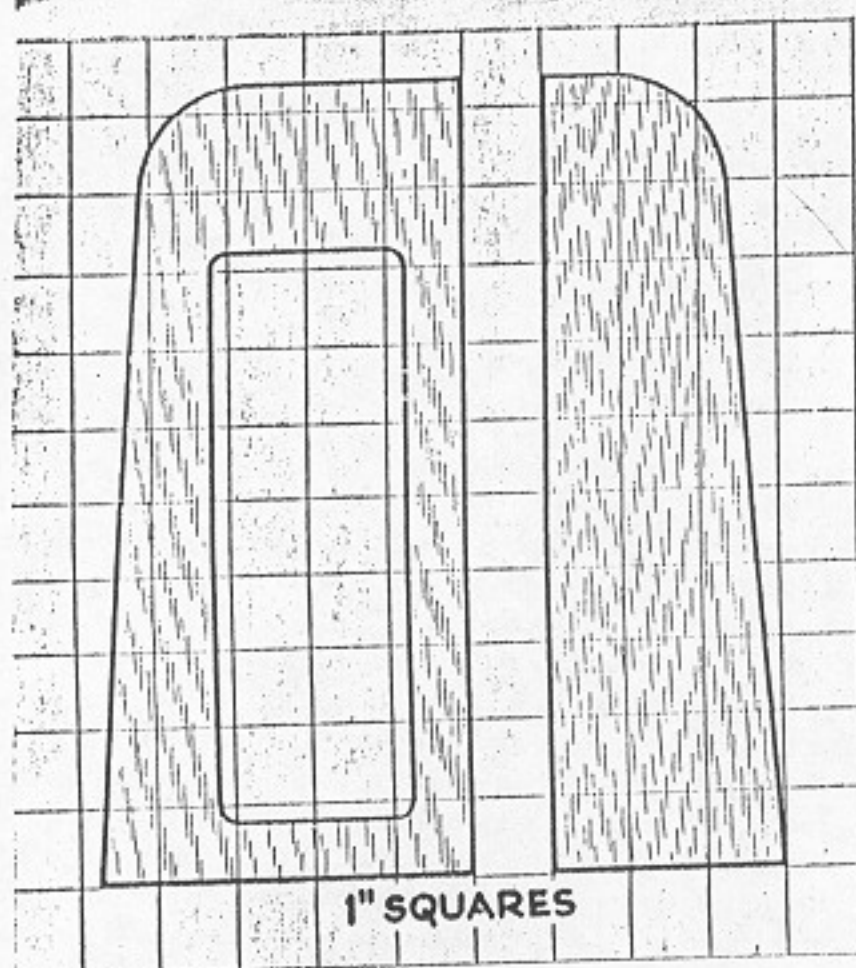
How electroplating works. When you pass an electric current through certain chemical solutions, particles from one electrode (the anode) are attracted to the other elec-



Homemade plating rack, a slick-looking rig, actually is built up easily with five layers of $\frac{3}{4}$ " plywood making each end support. Aluminum electrode bars slip into notches at top.

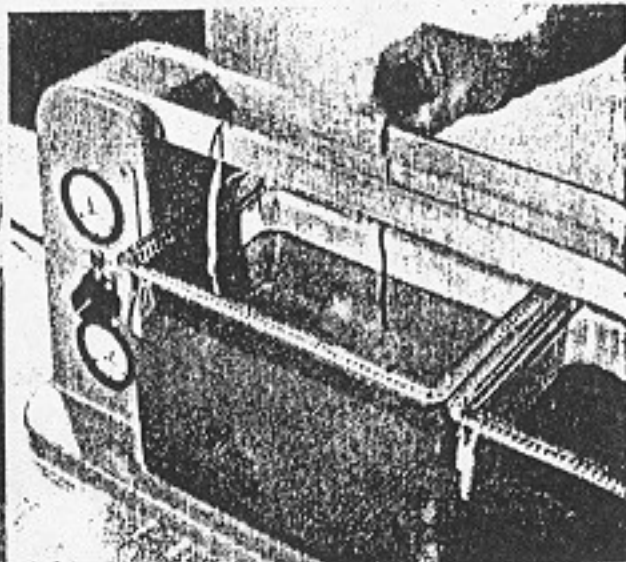
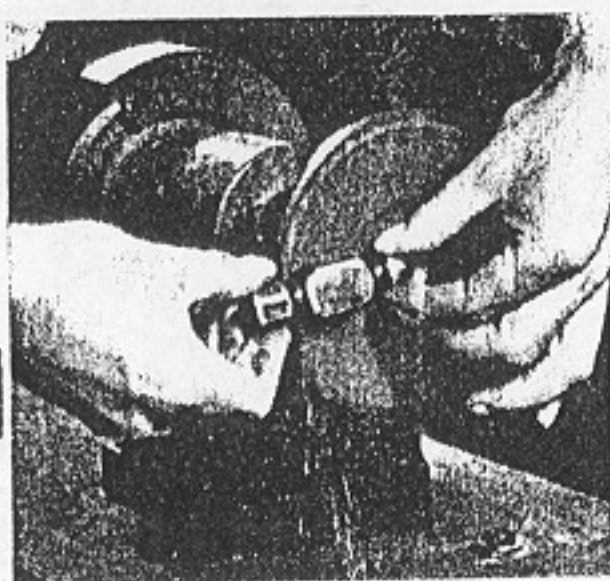
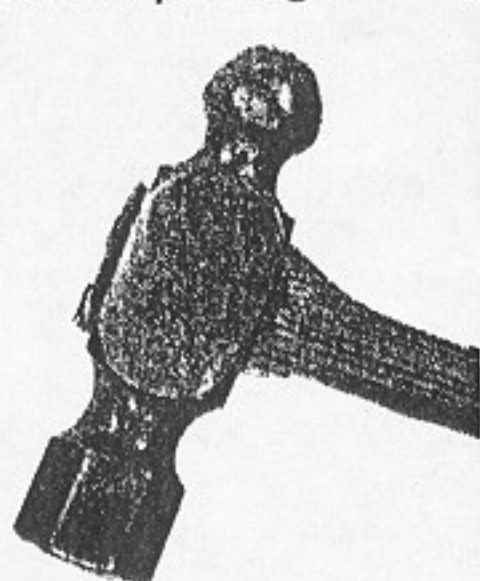


Electrical controls mount on a plate and fit into a cutout in one end support. Fuse and receptacle go in back on a similar plate. Drill holes in the plate to vent rheostat heat.



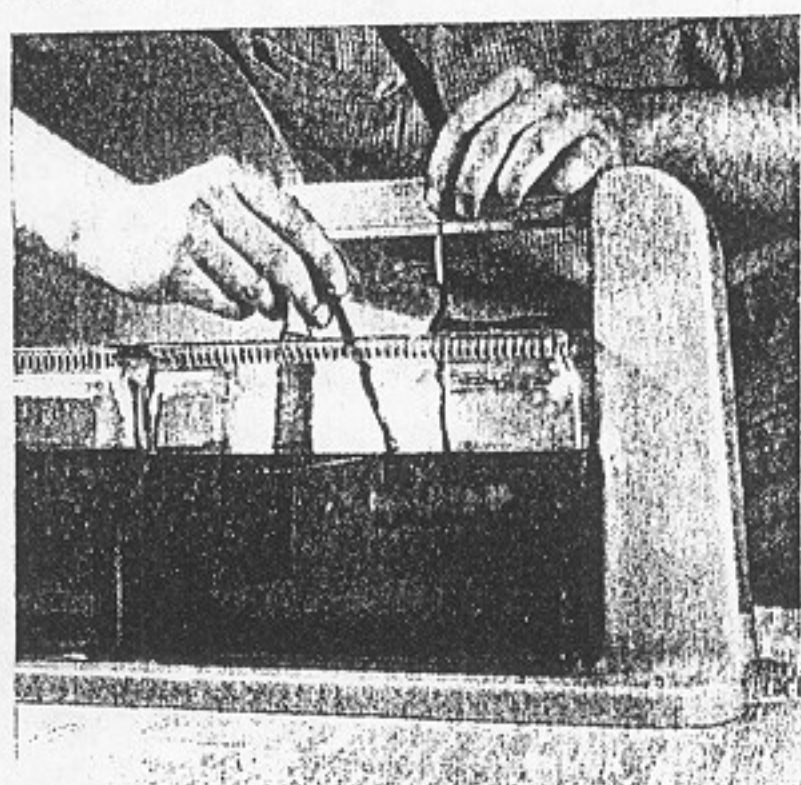
Simple circuit controls power to plating tanks through a rheostat and meters. Note that polarized plug is a must to be sure you always connect negative to cathode, positive to anode.

How to put a gleaming nickel plate on an old steel tool

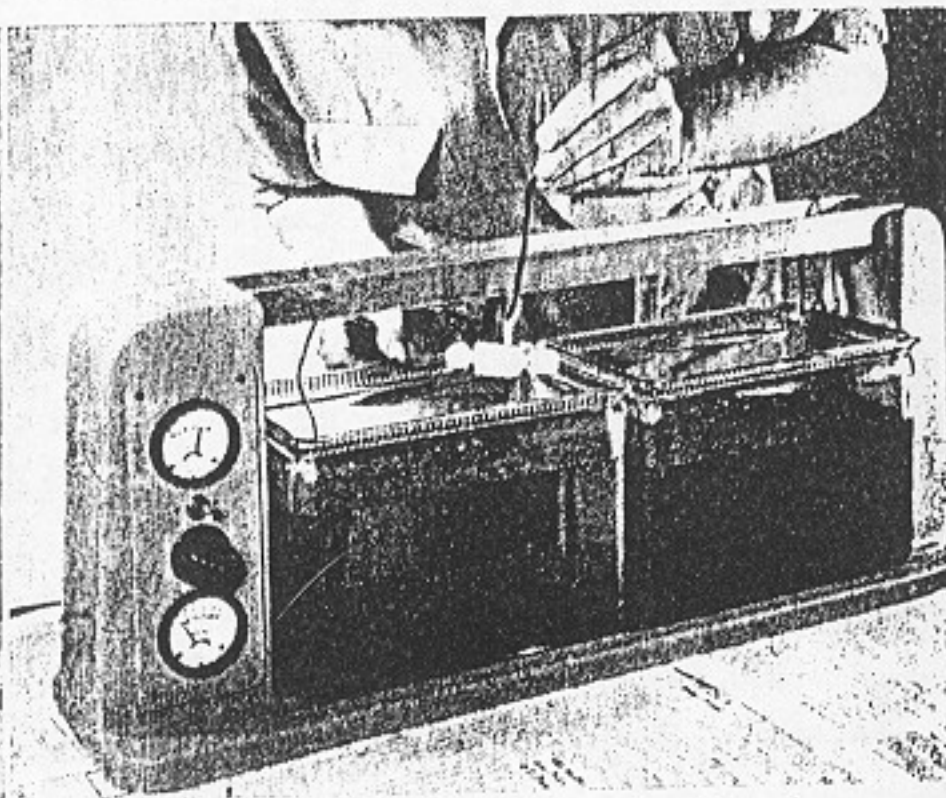


Age-darkened hammer head at left is first polished on a flexible disk of fine-grit abrasive cloth (center). It's then given an anodic etch—suspended from the plating rack's anode bar in

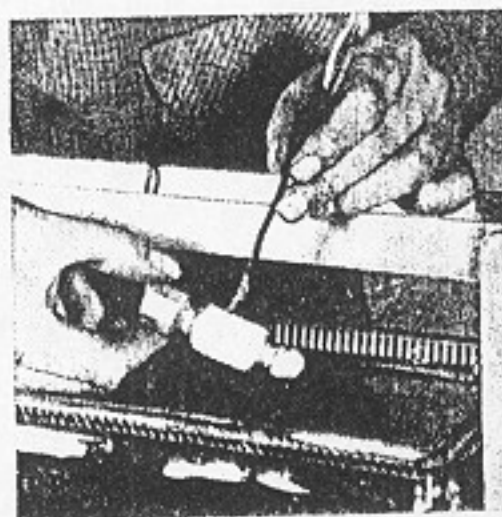
a tank of dilute sulfuric acid (right). The cathode is a scrap of sheet copper. Gas bubbles indicate the process is working. Anodic etching makes steel receptive to nickel.



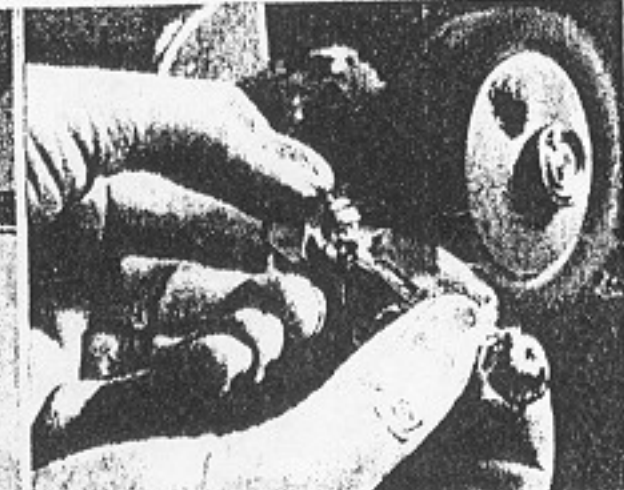
Nickel flash—a very thin nickel deposit—is put on next by suspending the head from the cathode bar in a nickel solution for about two minutes (left). Any bubbles that form should



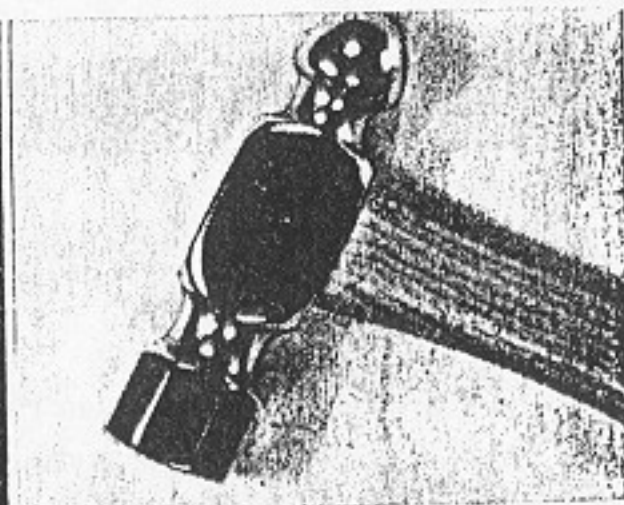
be brushed away. The head is then transferred to a tank of copper solution (right) and given a substantial copper plate. This serves as an underlayer for the final plating of nickel.



After copper plating, the head is put back in the nickel tank for the final thick plate. After about half an hour, it takes on a smooth, silvery-white look (left), indicating a satisfactory



nickel deposit. It's then buffed bright with white-rouge compound on a cloth wheel (center). Add a fresh handle and see what a difference the tough, shiny new finish makes.

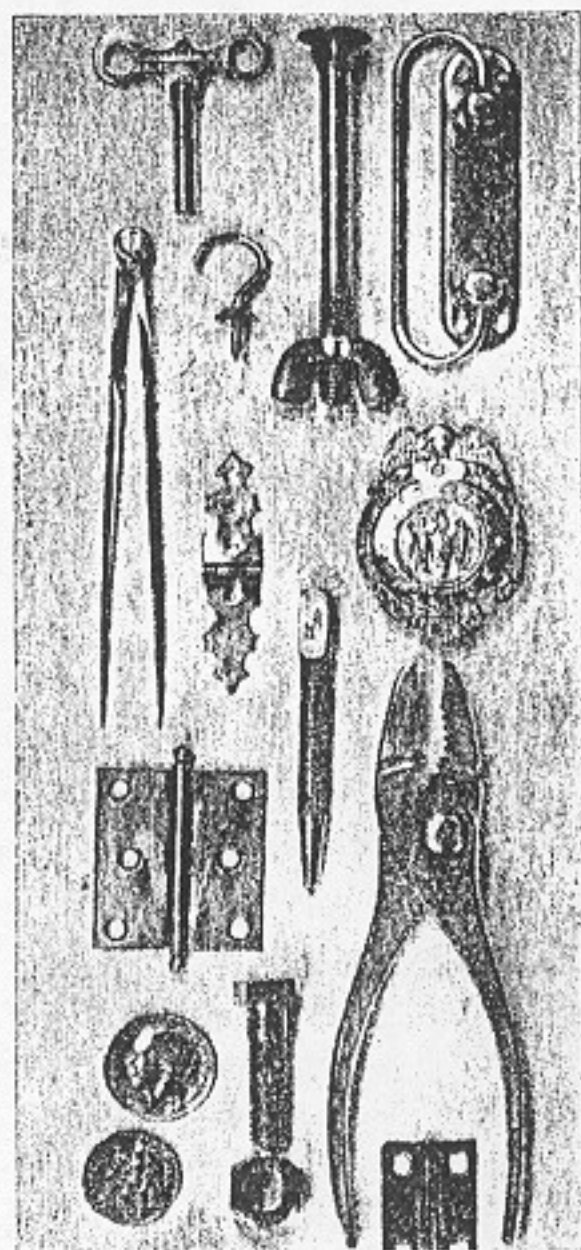


trode (the cathode). So you make the cathode the object you want to plate and the anode a chunk of the metal that you want to do the plating. As current flows, the anode metal slowly dissolves in the solution and becomes free metal ions that are attracted to the object that's to be plated. The ions gradually collect on the object and become crystals of pure metal. Eventually, the crystals build up a layer of solid metal, and the object is permanently plated.

In the setup shown here, two aluminum bars are used to carry current across the tops of the plating tanks. One represents the anode and the other the cathode. Objects to be plated and the plating metals are simply hung from the bars on wire hooks. There are no electrical connections to make, and the suspended objects can be quickly switched from one tank to another.

Plating solutions. The chemical solution you use depends on the kind of metal that will form the plate. The solution must contain free ions of the plating metal in order to start the chemical process going. A copperplating solution, for instance, must contain some free copper ions to begin with. As these ions are used up, the copper anode is etched away to provide a constant supply of new ones.

There are two basic types of solutions, acid and alkaline. Acid baths for copper, nickel, and zinc plating are the simplest and safest to use. They're mixed with harmless metal salts, generally sulfates or chlorides, to provide the free metal ions. Mixing proportions aren't critical, and the baths can be used at room temperature over a wide variation in current.

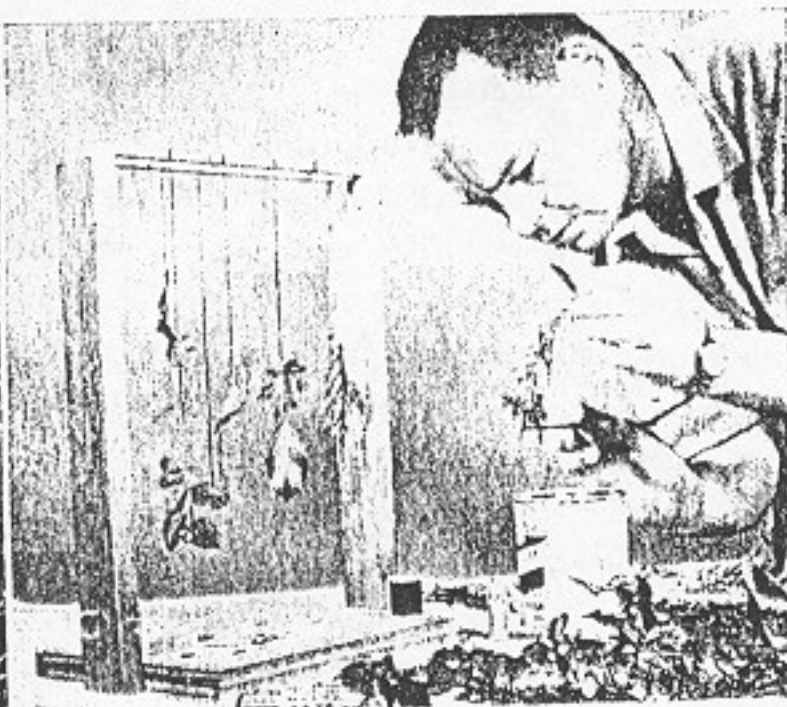
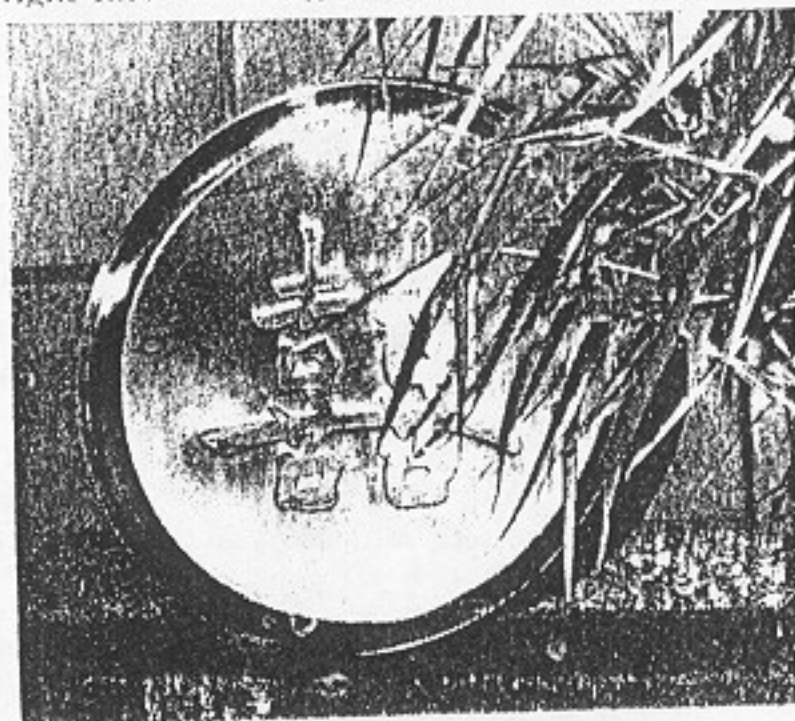


Ordinary household objects take on a glittering sheen—as well as lasting protection against corrosion—when you plate them this way.

Two offbeat plating tricks produce eye-catching decorations

Two-tone plating is possible this way. Here, the design in a copper tray was nickel-plated by coating everything but the design with resist—a compound that prevents plating. The etching and plating solutions were then poured right into the design without using a tank.

Nonmetallic objects, such as these leaves, can also be plated. The secret is to coat them first with an electrically conductive paint to carry the plating current. You can make such a paint yourself by mixing grease-free bronze powder with a little thinned spar varnish.



PLATING SOLUTIONS

Copper

28 oz. copper sulfate
4 fl. oz. sulfuric acid
(28% battery acid)
½ tsp. white Karo syrup
1 gal. water

Use at room temperature with tank current of 10 to 30 amps per square foot at 1-4 volts. Buy copper sulfate at garden shops, drugstores, chemical houses. Many gas stations stock 28% sulfuric acid. Use sheet-copper anodes. Flash steel objects in a nickel bath before copper-plating in the acid copper solution above. Agitate and turn work.

Nickel

32 oz. nickel sulfate
6 oz. nickel chloride
4 oz. boric acid
1 gal. water

Use at room temperature with tank current of 10 to 20 amps per square foot at 1 to 2 volts. You can buy nickel salts and a pure nickel anode from a platers' supply house or from a commercial plater. Drugstores sell boric acid, which should be dissolved in a little hot water before it's added to the solution. Avoid contaminating nickel solution with zinc.

Zinc

32 oz. zinc sulfate
3 oz. ammonium
chloride
(sal ammoniac)
1½ oz. sodium acetate
½ tsp. white Karo
syrup
1 gal. water

Use at room temperature with tank current of 10 to 30 amps per square foot at 1 to 3 volts. You can buy zinc sulfate, sodium acetate, and ammonium chloride from a pharmacist. Use zinc anodes—old printer's line blocks are generally zinc. Agitate and turn work.

Some metals, however, can't be plated from simple acid solutions. It's necessary to use alkaline solutions to plate with brass, silver, gold, or rhodium. Alkaline solutions are required for plating zinc die castings.

Since alkaline solutions usually contain potassium cyanide or sodium cyanide, both deadly poisons, alkaline solutions must be cautiously handled in a well-ventilated shop area. If a cyanide is accidentally mixed with acid, hydrocyanic-acid gas, instantly lethal, is generated.

Acid solutions are therefore best for home-shop plating and will handle most of the finishes that you're likely to want. The accompanying table tells you how to mix the three most common—for copper, nickel, and zinc. The chemicals listed, as well as anode metals and other equipment, are available from plating-supply houses. (One good source is Ramyr Mfg. Co., 1779 N. Main St., Los Angeles.)

Freshly mixed solutions, especially for nickel, often give irregular results when first used. Plating a few chunks of scrap metal will break in a new batch. You can mix and store solutions right in the tanks.

Building your plating rack. This is simply a wood base large enough to take two fish tanks with uprights at the ends to support the aluminum bars. The uprights are built-up sandwiches of five layers of ¾" plywood, jigsawed to the profiles shown. The two

current-carrying bars are ¾"-by-1" hardware-store aluminum, notched into the tops of the uprights.

The fish tanks used here are the 1½-gal-lon rectangular type sold in dime stores for about \$1.80. Other sizes and types of tanks are also available from lab-equipment supply houses. Adjust the length and height of the rack to take whatever size tanks you buy. The aluminum bars should run about 2½" above the tanks.

The power supply. The thickness of plate you get depends on the amount of electricity that flows to each point on the cathode. A plater figures tank currents in terms of "current density," expressed in amps per square foot of cathode area.

Don't let this throw you when you find some plating jobs calling for 20 to 30 amps per square foot. Most of the objects you plate will have a surface area of only a few square inches.

An ordinary six-volt auto-battery charger, which delivers about six amps, is thus a slick power supply for home plating. The selenium-rectifier type shown cost about \$15. In a pinch, you could also use a regular car battery and recharge it periodically. Or you could buy a used lab-type plating rectifier. A TV repairman's DC power supply is ideal.

You'll need some electrical controls for

governing the tank current—a large rheostat, voltmeter, ammeter, switch, fuse holder, and polarized plug. A 50-watt, 25-ohm wire-wound power rheostat will do nicely and costs around \$5. The meters shown, a 0-10 DC voltmeter and 0-10 DC ammeter, cost under \$2 each from supply houses like Allied, Lafayette, and Radio Shack.

Wire these parts as shown in the diagram. They fit into a recess in the left-hand upright, formed by jigsawing cutouts in the plywood layers. The aluminum-bar electrodes are connected to the power leads by two brass-rod terminals that extend through holes from the top of the left-hand upright into the control-compartment recess.

Copperplating most base metals involves cleaning the work to be plated carefully and suspending it in a copper solution on wire hung from the plating rack's cathode bar. Sheet copper will serve as an anode.

Cleaning is the crucial step, for any grease, oxide, or scale on the work may prevent the deposit from adhering. One easy way to clean an object for plating is to polish it with very fine grit abrasive cloth on a flexible disk sander. Then scrub it thoroughly with grit-soap suds (Lava soap) and household detergent. When the metal is spotless, dry it with a soft cloth. Avoid touching the surface—even a greasy fingerprint can cause trouble.

After providing a wire hanger, dip the object momentarily in dilute sulfuric acid—28-percent-strength, dry-charge battery acid. Then turn on the plater and lower the work into the copper bath. There's no shock hazard at the low voltages used.

A pinkish copper deposit forms immediately. Should it turn mottled brown, too much current is flowing—adjust the rheostat for lower amperage. Voltage isn't critical. A little experimentation will determine the best rheostat setting for fast, smooth plating. It will take perhaps a half-hour to plate on a heavy layer of copper.

When plating a thick copper deposit, lift the work from the bath occasionally and smooth off any roughness with very fine wet-or-dry paper. Then replace it in the tank. Agitate and turn it now and then.

Plating iron or steel in an acid copper bath requires special procedure. If ferrous metal is plated directly, the deposit will be spongy and nonadherent. Before coppering steel, therefore, first give it a flash plate—

a very thin coating—in an acid nickel solution. And before you flash it, etch the steel anodically to make the nickel adhere.

Anodic etching is accomplished by hanging the work from the plating rack's *anode bar* in a tank of battery acid. Use scrap copper for a cathode, and turn the rheostat to increase amperage until gas bubbles vigorously from the immersed steel. The bubbling will float off dirt and oxide, and the etched steel will take on a silvery mat surface. This may take five or ten minutes.

Then rinse the work, transfer it to the nickel bath, and flash-plate it for two or three minutes at low current density. After this flashing, the steel is switched to the acid copper bath and plated with as heavy a copper deposit as desired.

Nickel plate is ordinarily deposited over a thick copper underplate. This underplate should be polished smooth with wet-or-dry paper and pumice.

If the current in the nickel tank is too strong, gas bubbles from the cathode and the deposit turns dull gray. If the current is too weak, the deposit will flake off.

While nickel adheres well to copper, it doesn't adhere well to nickel. Therefore, be careful not to interrupt the flow of current. Don't remove the work for examination and, when turning it, avoid breaking contact with the cathode bar. For top protection against corrosion, build up a composite plate with alternate layers of copper and nickel, finishing with nickel.

Zinc plating baths are handled much like acid copper baths. An acid zinc bath, however, is less able to plate into recesses. Turning the work frequently helps.

Nearly any nonmetallic object can be plated successfully if first brushed with an electrically conductive paint, as shown in a photo. The popular trick of plating baby shoes, pine cones, and other nonmetallic objects can be done this way. Use this same technique to electroform intricate parts. Make a plaster negative mold, give its face a conductive coating, then build up a full copper deposit.

Chrome plating requires special equipment. You can plate precious metals with your rack, however, using Pyrex coffee pot bodies for tanks and solution concentrates from a jeweler's supply house. Because the solutions contain cyanide, follow the instructions on the labels to the letter. ■ ■



A. NEELY HALL, Editor

Author of "Outdoor Handicraft," "Home Handicraft," etc.

SCIENCE AND MECHANICS SUMMER, 1943

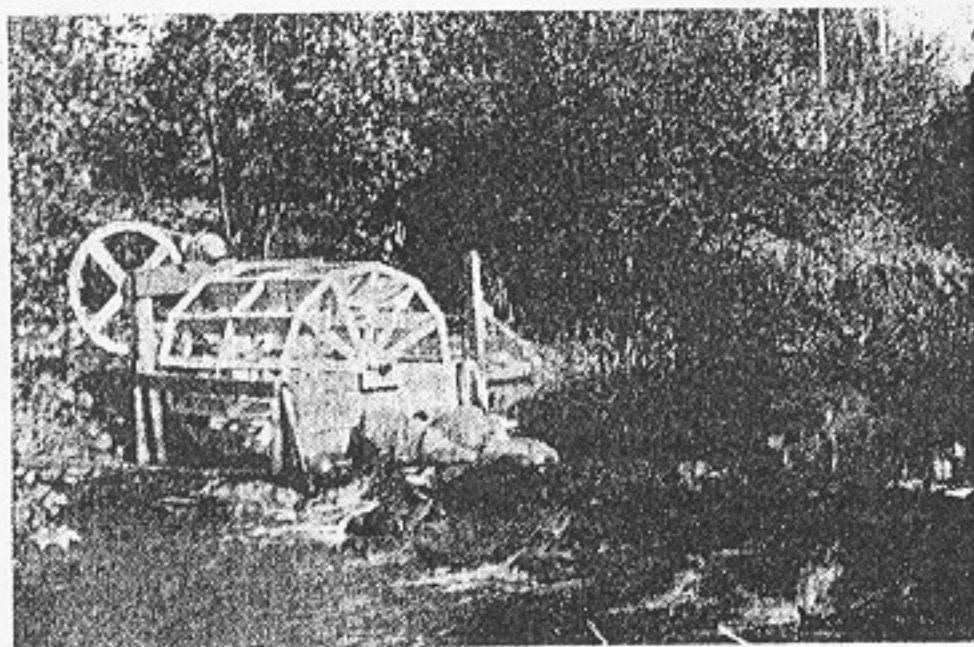
If You Want a Water Wheel —You Can Build This One

THIS summer, when wartime conditions are compelling a great many people to remain at home or at their summer cottage, seems to me to be a very good time for the man of the house to build that home-made water wheel he has long dreamed about for the little stream that runs through his property. That water wheel can do all sorts of things to make life more comfortable and more interesting around the home or the cottage. I know, for I have built one myself and it works. Moreover, I got a lot of personal satisfaction proving to myself that "it can be done."

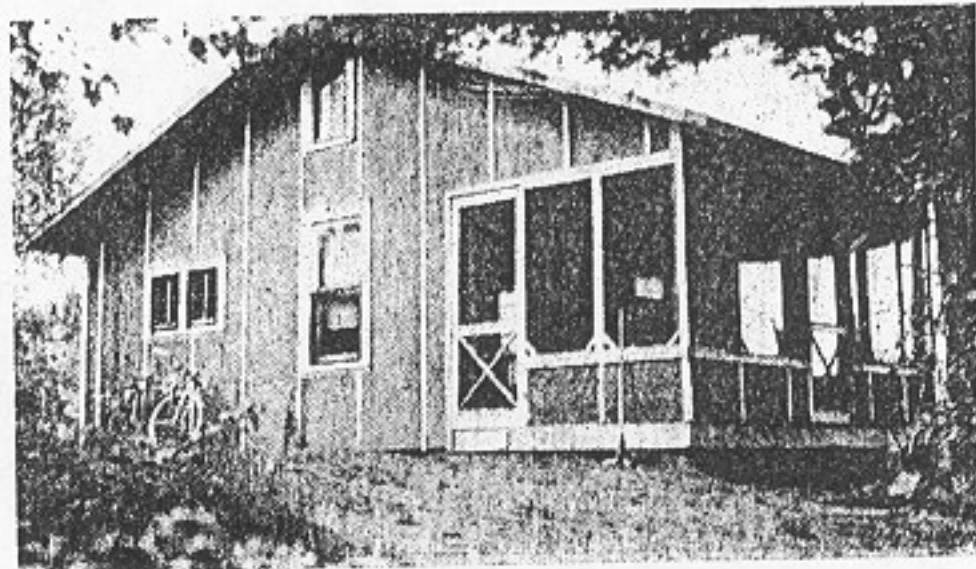
Countless rural areas in our country have hundreds of small streams with small waterpower possibilities that are being ignored at the present time. And I have no doubt that many owners of lands across which these streams run would be surprised if they knew the power possi-

Made almost entirely of used material, this small stream wheel lights a cottage, runs the radio, pumps water, and can be stored away for the winter.

By J. H. THORNGATE



Rocks and planks help increase the head of water needed for this homemade water wheel.



bilities of these little brooks and creeks. My own summer cottage is located on a little stream called the "Weirgor" at Exeland, Wisconsin. Here I built the homemade water wheel described and pictured in these pages. The total cost was exceedingly low, almost nothing in fact, and it can be duplicated or

Current generated provides for all the lights in the cottage and for the radio too.

modified to suit the needs of any stream owner.

My actual outlay of cash for this wheel was less than \$8.00. The items cost: 2 galvanized iron sheets \$2.00, 7 ft. of iron pipe \$.56, drive belt \$.48, generator belt \$1.09, generator pulley \$.35, voltmeter \$.59, ammeter \$.59, gen-

erator cutout \$.19, 2 switches \$.22, bronze bearings \$.15, and small hardware \$1.50. This totals \$7.71, certainly a low cost.

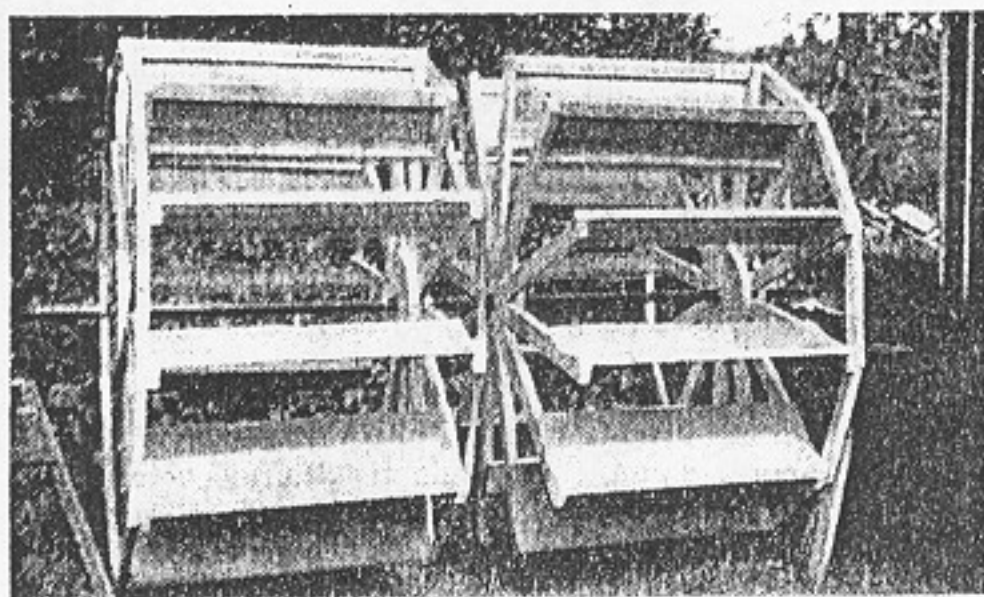
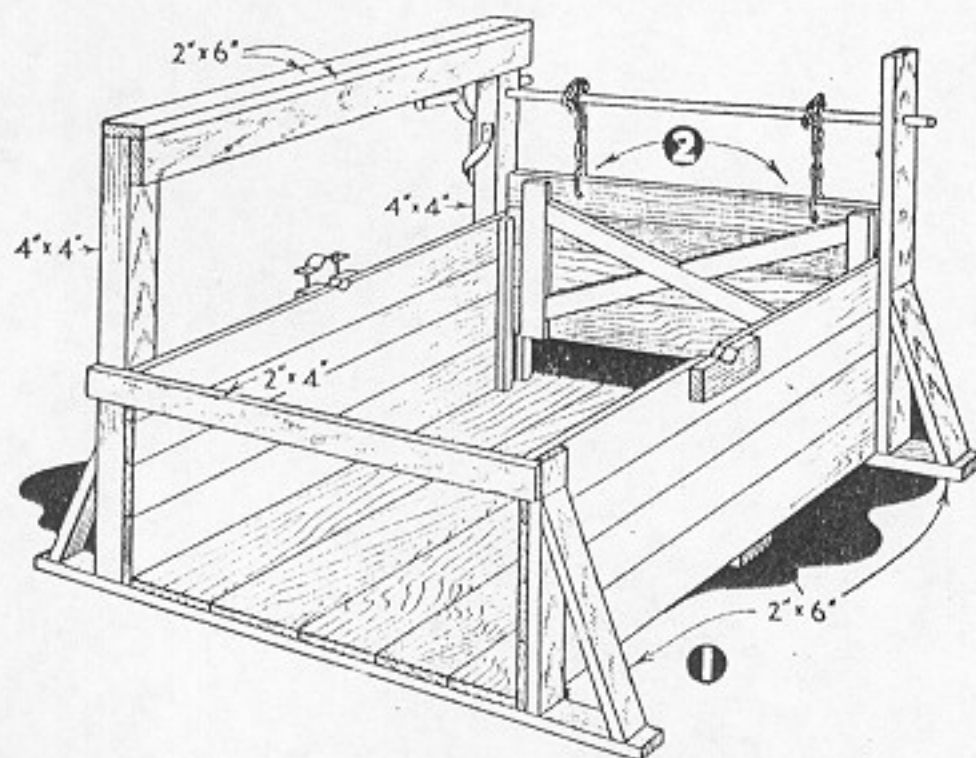
Practically all material had been used before including lumber not listed above. The plant generates electricity for the lights in the cottage, supplies the electricity needed for my radio, runs a two-cylinder water pump, supplies pressure for 200 feet of hose, and the entire plant can easily and quickly be taken down and stored in the cottage over winter.

From the plans and pictures given here, it can be seen that the water wheel is made in two sections. This was done so that each section can be passed through the cottage door. This wheel was made almost entirely from the boxes in which I shipped books to my cottage from my home in Eau Claire, Wis. I ripped out the pieces by hand and then cut the necessary curves with a draw shave. The blades are made of galvanized iron.

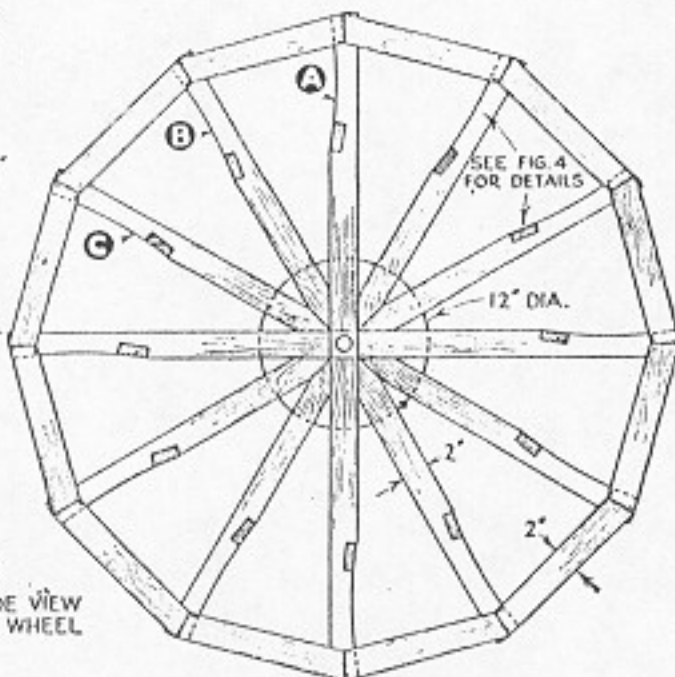
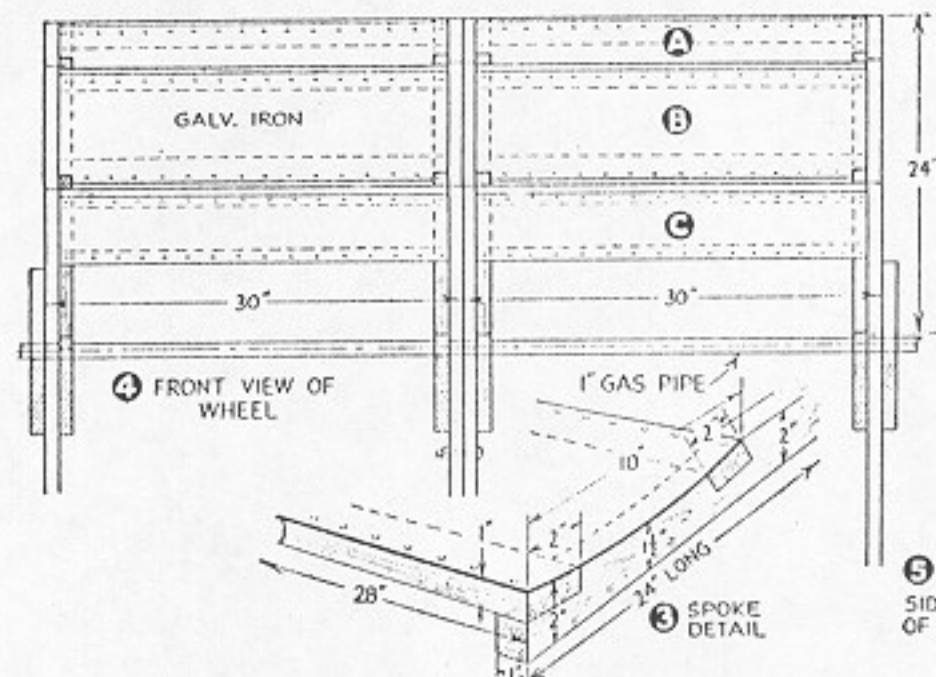
The sluice-way was made from old boards and posts that were around the place. The shaft of iron pipe was drilled and the wheels pinned to it with three $\frac{3}{8}$ -inch rods each 8 inches long. The two bearings in which the shaft turns were obtained from a junk heap at no cost. Figs. 1 and 2.

The main drive wheel is an old auto front wheel with a wooden flange set to help keep the drive belt in place. The large wheel that drives the generator is made from $\frac{3}{8}$ -inch wood from boxes. It is built up in sections, each of which was sawed by hand with a circle saw. The drive belt measures $1\frac{1}{2}$ inches. The generator is an old North East 12-volt, and it was given to me. Figs. 3 to 6.

The fuse was removed from the



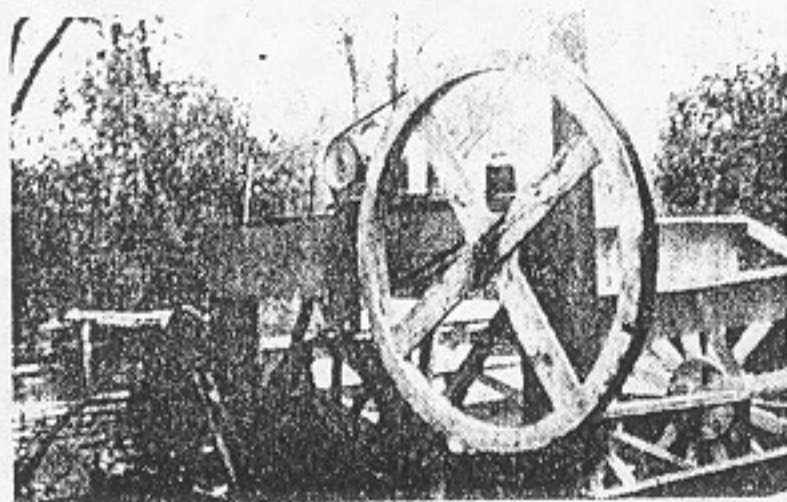
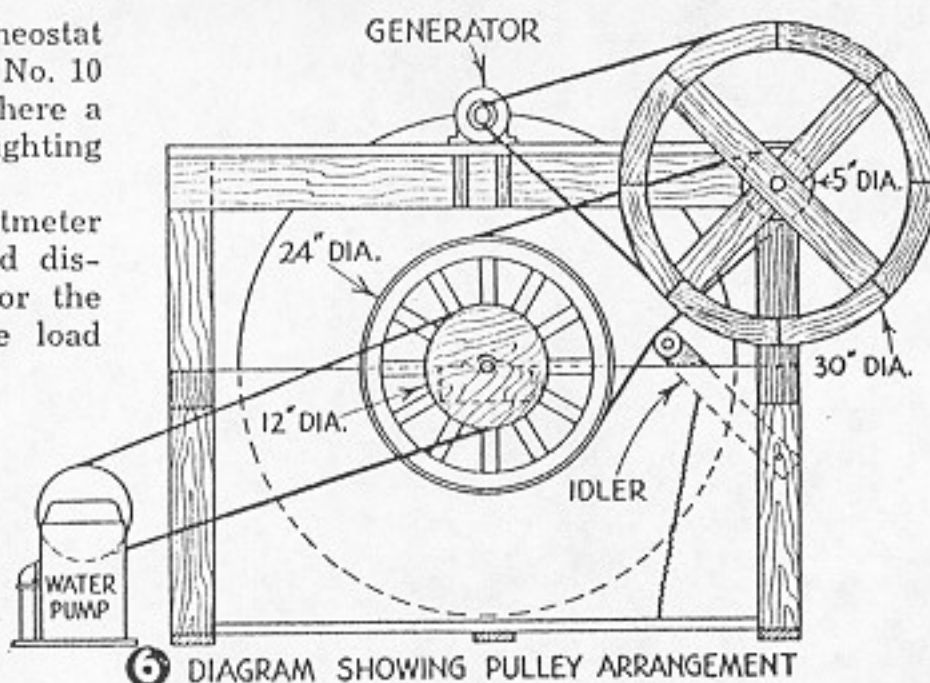
The wheel is built in two parts so that each half can pass through the cottage doorway for storage out of season.



generator. Two wires lead from it to a rheostat in the cabin, to control the voltage. Two No. 10 wires carry the current to the system where a 6-volt car battery is in parallel with the lighting system of six lamps and a 6-volt radio.

The panelboard in the cottage has a voltmeter and an ammeter which show charge and discharge, the generator cutout, a switch for the charging current, and a switch for the load circuit.

For water head in the stream, I built up a rock dam aided by planks on one side which help me control the water. The dam and the wheel not only develop my electric current but they also help to aerate the water of the stream and that is an excellent thing for the trout that live in it.



Old lumber and a circle saw were all that was needed for building the generator driving wheel.

This system, including the outside wiring, can be installed or removed in an hour's time. It is installed each June when school work is over and removed when I return to my school work in September. The wooden sluice-way itself, however, is not removed from the stream during the winter. The headgate, hung on chains and lifted by a crank, is removed to allow a free flow of water during the fall and winter. This is not sufficient to damage the dam or the sluice-way.

The minimum depth of water that will turn the wheel is eight inches. This will turn the wheel slowly and the rate of charge is low, but it is sufficient to charge the batteries satisfactorily. The natural fall of water from a point 100 feet above the wheel to a point 100 feet below it is not more than three or four inches. This difference is increased by the rocks and the dam.

When the wheel is in use, the distance between

the lower edge of a blade and the floor of the sluice-way does not exceed one-half inch. This is close fitting perhaps, but it helps to make the largest possible use of the head of water passing under the wheel.

Under good current, the speed of revolution of the wheel under load is between 20 to 25 r.p.m. There is no chance of the wheel operating too rapidly in case of heavy water after rains because the actual head of water even then can be readily controlled by use of the headgate.

From the plans and pictures it will be seen that the main drive wheel also drives the two-cylinder water pump, with which the 200 feet of hose is connected. This pump is an old timer which was obtained at no cost from a junk heap.

Notice also that an idler is set against the belt connecting the main driving wheel and the generator driving wheel. This prevents loss of power and slipping that would result from a too loose belt. It should be set carefully. The generator itself is bolted to the plank which supports it.

Whoever builds a water wheel like this one should construct accurately the spokes and the curved blades, and thus make sure to get the largest possible pressure from the head of water that is available in his own stream.

Too often owners of small property with a stream running through it imagine that it costs a lot of money to install even a small water-wheel for developing electrical current for light and power. But this need not be the case at all. I think I have shown how successfully it can be done at even a low cost.

There are on the market, of course, many mechanical and electrical devices for use in small waterpower developments, but it is not absolutely necessary to lay out substantial sums of money for their purchase. Much can be done with used material, as I have shown.

Furthermore, why miss all the fun of building a homemade dam, one made of used materials that can quickly be picked up around one's own place or obtained at little or no cost from some nearby junk pile?

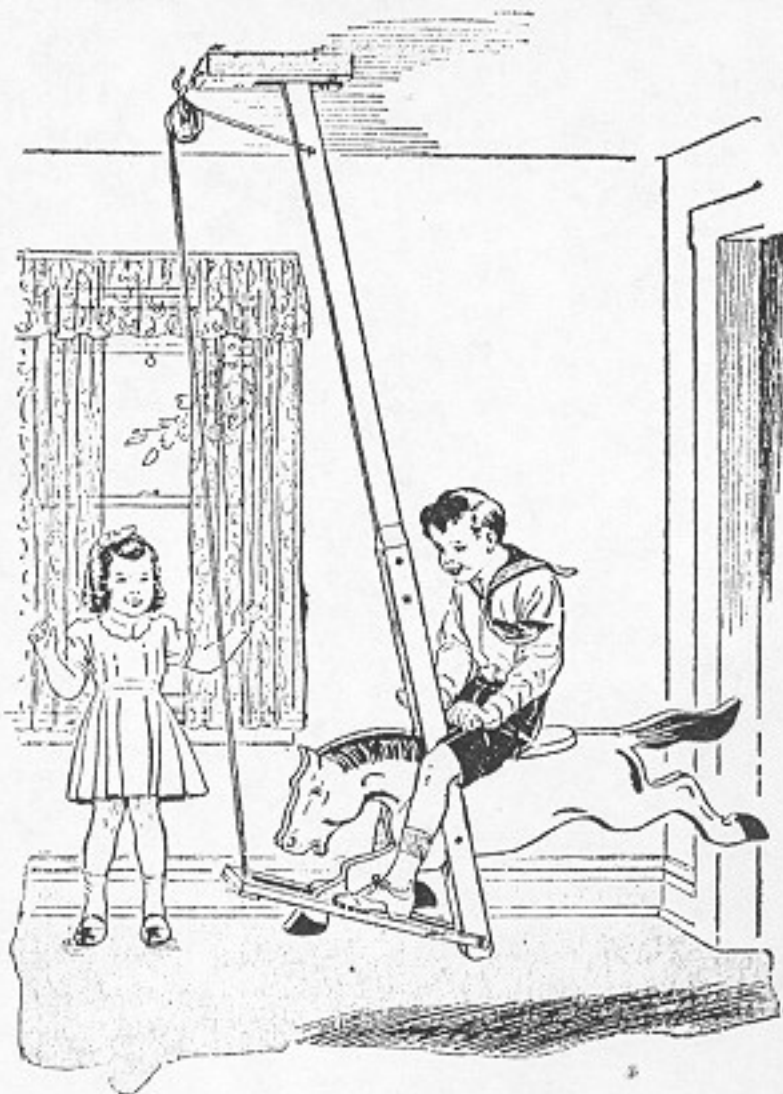
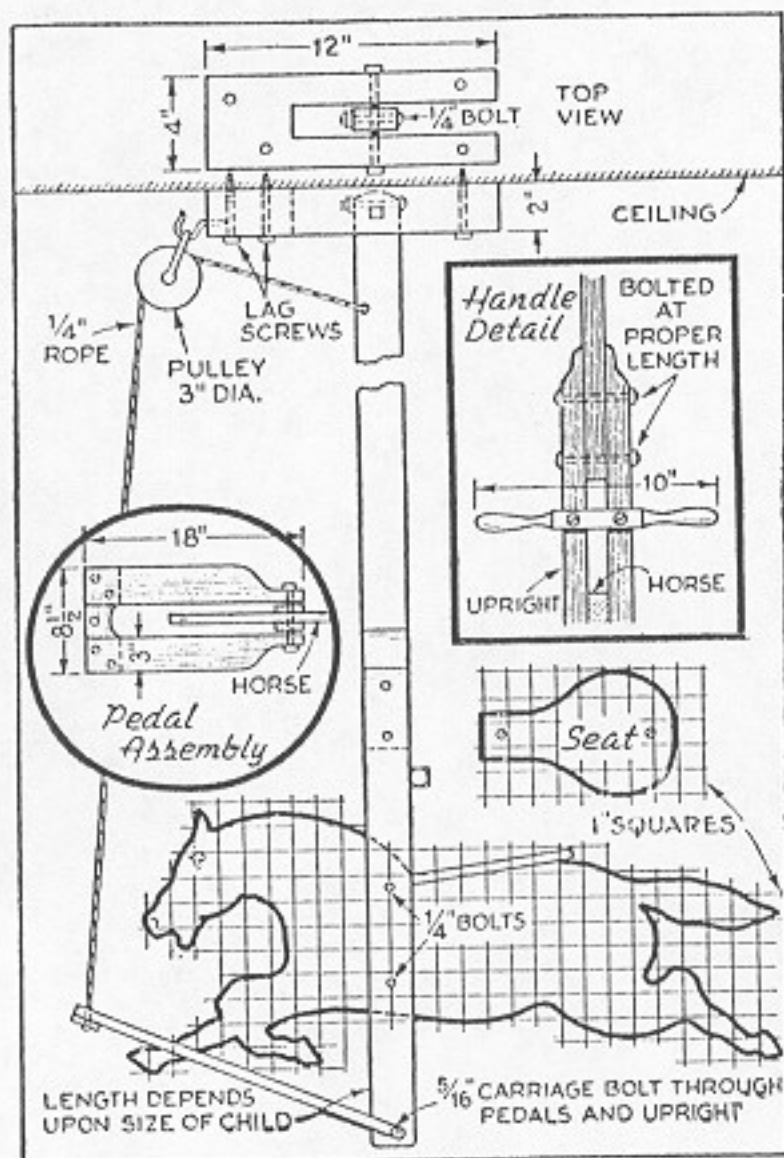
J. H. Thorngate, a contributing reader of *SCIENCE AND MECHANICS*, is chairman of the science department of the Senior High School, at Eau Claire, Wis. When school closes for the summer, he waves good-bye to his pupils in physics, biology and chemistry, and goes away to his cottage in the woods at Exeland, Wis., where he built the water wheel he describes in this article.

—The Editor

Swinging Pony Toy

OPERATED BY PEDALS

PRESSING on the foot pedals keeps this swinging pony in motion. The harder it is pedaled, the higher it will swing. Cut the horse and seat from $\frac{3}{4}$ " stock, preferably hardwood, and sand the edges round. The



swinging support is made from three pieces of wood, as indicated, with a handle added. In the upper end of the support a $\frac{3}{8}$ " hole is bored for the swing pivot. Just above this hole, bore another in the opposite direction for a $\frac{1}{4}$ " bolt, which acts as a bearing and prevents the pivot bolt from pulling out.

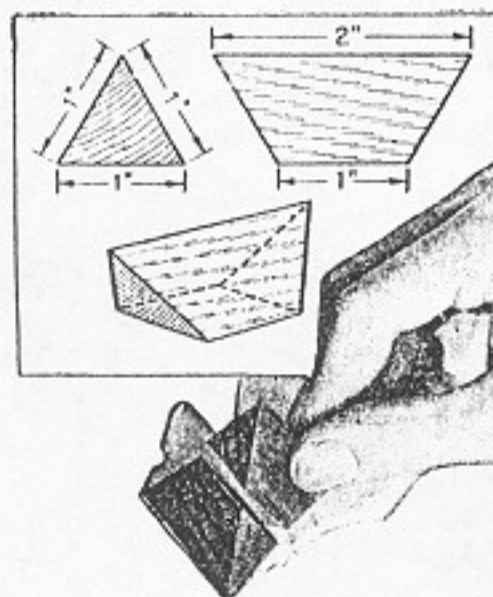
The ceiling support is made from 2" by 4" stock with a slot in it to take the swinging arm. The pedals must be long enough to clear the front legs of the horse. Fasten the rope as shown. When hanging still, the front of the pedals should slope up. The horse may be made larger than in the drawings, if desired.

Two-Piece Pyramid Block Puzzle Is Tricky to Solve

MORE difficult than it looks, and likely to confound some self-styled experts, is the apparently simple puzzle shown at the right. It is easily made by planing a stick of walnut or other suitable wood into the form of a 1" triangular prism about 6" in length.

From this cut two pieces to the dimensions shown in the drawing. The problem is to place these two pieces together so that they will form a three-sided pyramid. This can be done as shown in the accompanying photograph.

A handsome and durable puzzle of this kind can be made from hardwood, suitably stained and polished. The popular cast-resin plastics may also be used.



The trick is to place the pieces to form a three-sided pyramid

Making a Six-Volt Electric Fence Unit

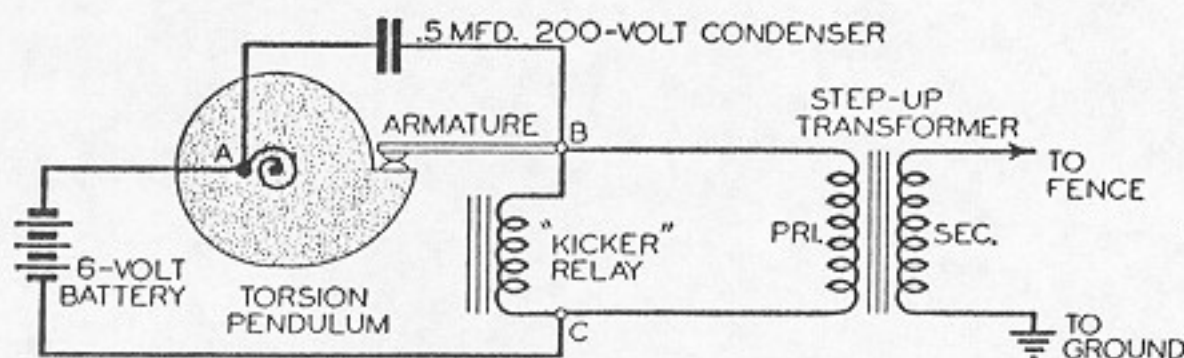


Fig. 1. Circuit diagram of the improved six-volt electric fence unit. A torsion pendulum and relay acting together serve to interrupt and conserve battery current.

SCIENCE AND MECHANICS OCTOBER, 1940

SHOCKING effectiveness, economy of battery life and safety are the three outstanding features of this simple battery-operated electric fence unit. You can build it yourself in a few hours at a cost of but a few dollars, either from a complete kit of parts or from the individual parts.

An electric fencer can be used on farms to electrify one-wire fences for livestock, making these low-cost fences even more effective than elaborate woven-wire or barbed-wire fencing.

Around homes, the uses for electric fence units are limited only by the ingenuity of the builder. Flower beds and prize trees can be protected from dogs; garages can be wired to scare off petty thieves; poultry nests can be cleared of setting hens in a jiffy; garbage cans can be electrified to discourage inquisitive, perpetually-

hungry dogs and cats; your automobile can be charged so that anyone touching any part of it receives a jolting but harmless shock.

A simple flywheel, more properly called a torsion pendulum, acts with an ordinary relay to interrupt the battery current at a rate varying from 50 to 100 times per minute. As the circuit diagram in Fig. 1 shows, battery current flows only when the flywheel contact touches the armature contact. When contact is first made, the sudden surge of current through the primary of the step-up transformer induces in the secondary a voltage pulse estimated to be about 4,000 volts. This high voltage makes the unit effective in dry as well as wet weather, yet is harmless because the accompanying output current is extremely low and flows only for the extremely short interval of time when current through the transformer primary is changing.

Battery current also flows through the relay coil when contact is made. The relay armature snaps down almost instantly, giving the flywheel a "kick" which makes it rotate an amount dependent upon the stiffness of the flywheel torsion spring. When the flywheel reaches the limit of its rotation, the spring brings it back again. The relay-closing action interrupts the battery circuit, so that the relay opens almost immediately again. No current flows during the entire

time the flywheel is in motion. A .5 mfd. condenser minimizes sparking at the contacts.

The fact that battery current is drawn only for very short intervals of time made it possible to operate this electric fence unit continuously for five months on a single "hot-shot" battery during life tests in a laboratory. A storage battery gave about 5½ months of operation before requiring recharging. Battery consumption

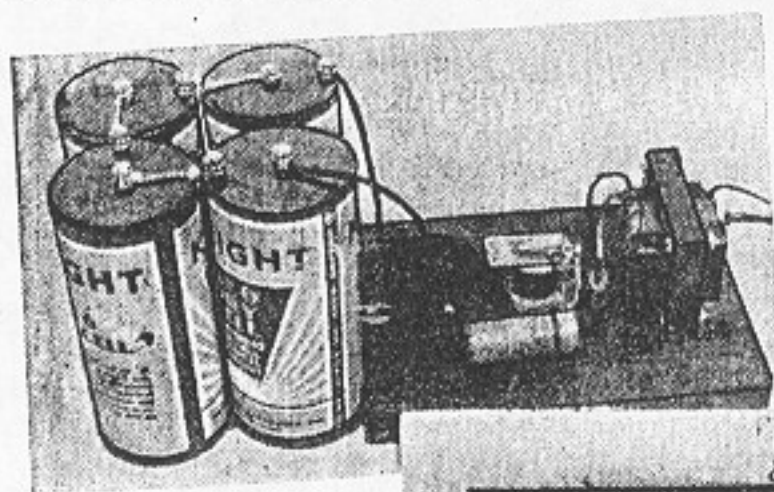
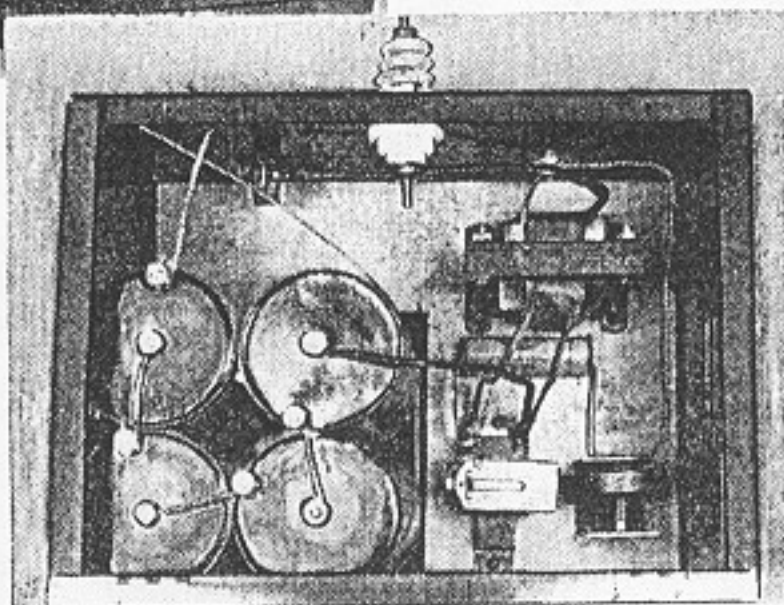


Fig. 2. Completely assembled six-volt electric fence unit on a plain wood base.

Fig. 3. Some may prefer to place the parts and dry cells in an attractive metal cabinet such as this.



will vary somewhat with the adjustment of the interrupter, but in any event, battery cost should not be much more than a penny a day.

The parts for this electric fence unit can be mounted on a simple wood base as shown in Fig. 2, with the batteries placed alongside. Placement of parts is not critical, except that the relay contact should be directly above the flywheel contact. It is a good idea to have both the unit and the batteries in a protective metal or wood

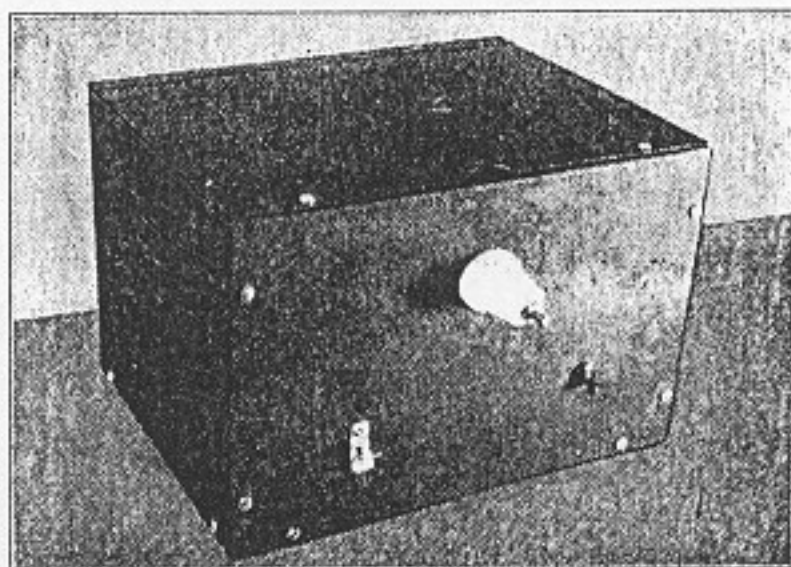


Fig. 4. Front view of metal cabinet for electric fence, showing from left to right the Fahenstock ground terminal, the insulated fence terminal and the ON-OFF s.p.s.t. toggle switch.

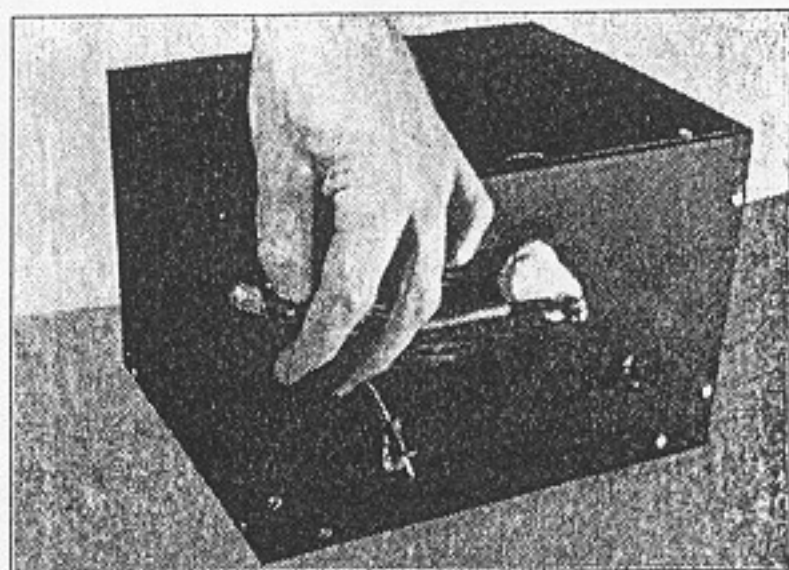


Fig. 5. Use of inexpensive neon test light for checking the electric fence.

box which will keep out rain and excessive dust.

Some may prefer to use the attractive metal cabinet shown in Figs. 3 and 4, mounting the two output terminals and an ON-OFF toggle switch on the front panel as shown. You can either use a "hot-shot" battery or four No. 6 dry cells connected together in series, as you prefer. The battery switch is placed in series with the battery.

Connecting the Parts

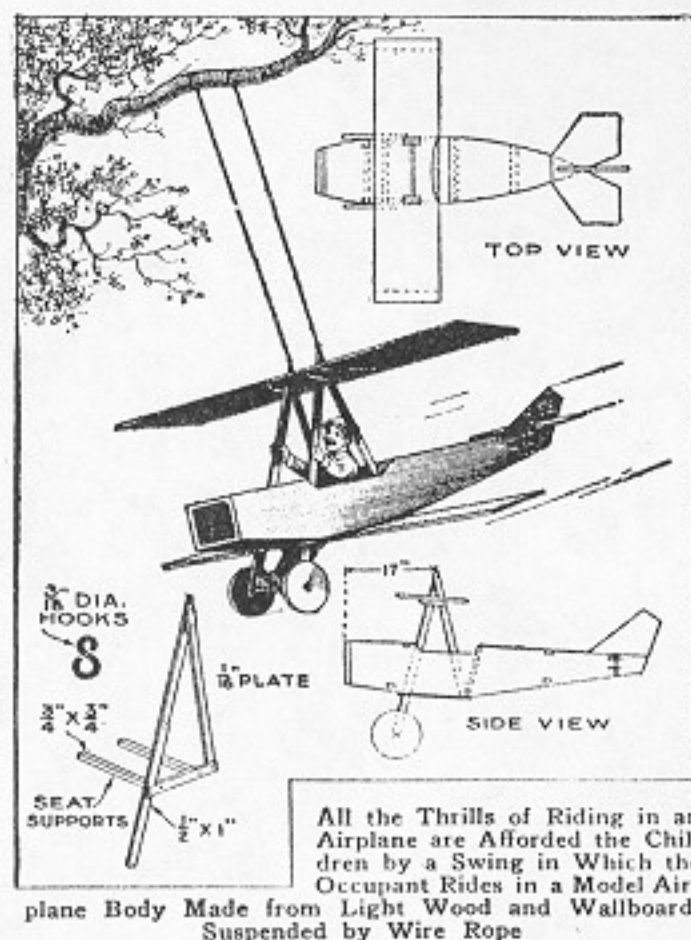
All connections between parts should be soldered carefully, otherwise the vibration produced by the relay will eventually break them loose. The ground terminal of the unit should be connected to a metal pipe driven into the

earth, while the other output terminal should be well-insulated and connected to the insulated fence wire.

An occasional drop of oil should be placed on the flywheel shaft. When relay operation can no longer be heard, the battery should be replaced. The relay contacts can be cleaned at the same time, even though they are inherently self-cleaning. Battery failure occurs when the voltage drops so low that the relay armature can no longer kick the flywheel far enough away to break contact; the circuit then remains closed, discharging completely the already-useless batteries. This means that when a storage battery is used, it should be tested at regular intervals and recharged before it is completely run down.

The neon test light shown in Fig. 5 makes it unnecessary to place your fingers across the terminals of the unit to determine when it is producing shocks. The lamp will glow for the duration of each shock, and its brightness will be a clue to the strength of the shock.

A neon test light will also tell you when the fence wire is grounded. Place the light across the fence terminals; if it flashes when the fence wire is disconnected, but not when the fence wire is connected, look for weeds, wires or other objects which are grounding the fence wire somewhere.



An Airplane Swing

Popular Mechanics — 1925

BUSINESS BY THE BUDDY SYSTEM

by Kurt Saxon

Everyone has thought of starting his own business but few have the willpower to actually get a business going. Those who do have the will-power to develop a marketable skill or a product, even on a part time basis, have a hedge against unemployment and become an asset to society.

Starting a small business doesn't need to be a major undertaking or expense. Hundreds of thousands of Americans have begun a business to save money and gone on to become independent. They began by producing something they used a lot. They sold or bartered the surplus. After a while they realized they had an expanding market and enlarged the project to a paying business.

Many have begun in the garden, gone on to a cheap greenhouse and expanded to selling specialized foods or decorative plants. One young couple began with a simple frame covered with roll plastic and now make up to \$45,000 a year selling only tomatoes.

Any husband and wife can start a cottage industry making something they're both familiar with and go on to pay most of the bills. When everything is learned about processing and marketing the product, the business is established almost automatically.

For starting a strictly cottage industry you can't do better than Dave Duffy's "Backwoods Home Magazine" and his first bound volume. There isn't a family who can't go through his material and find an enjoyable, profitable home business.

The subscription costs \$17.95 for 6 big issues for one year. The bound first 12 issues costs \$16.95 plus \$2.00 postage. These are a must. Send to Backwoods Home Magazine, 1257 Siskiyou Blvd., #213, Ashland OR 97520 (If using Visa/Mastercard call (503) 488-2053).

I guarantee, anyone with imagination and common sense can use Duffy's works to save money, make money and improve his chances for a better life.

Now for the buddy system.

You must have two or three friends who would work well together and join in a business making something to sell. Get together and choose a product. The SURVIVORS have so many trades and products you'd have to be fantastically dense and unimaginative not to be able to find something to make and sell. I think your emphasis should be first on a product to sell through local stores or from your home or shop, rather than nationally. In choosing products needed in your own community you establish a reputation which will insure your acceptance as a supplier of

future needs.

But in choosing a product, don't compete with locals. If a local is established and is already supplying a product or service, you're just wasting your time. Choose something no one else is doing. There are plenty of choices.

You might compete with outsiders, however. I was buying some vegetable plants for my garden and saw a truck full of such plants from Alabama which supplied Arkansas. Why couldn't some green houser in this area start such plants to sell through local nurseries? Then there was the \$2.00 a pound tomatoes from California. Why again didn't some local greenhouse supply them at a lower price and still make a good profit?

This is a doubly good point to show that as things get worse, you'll have real opportunities supplying locals with products they simply won't be able to get from the outside. Start now replacing out-of-state imports and soon you'll have the market cornered.

Food is a sure thing, although labor intensive. But if you're manufacturing, learn to use the Thomas Register. These are large green books found in most libraries. They register every product manufactured in the U.S.; Chemicals, containers, tools, machines, raw materials, parts, etc., it's all there.

Whatever parts you need for any business you want to buy from the source. Say you decided to turn out the little Gas Buster car from Vol. 8, page 93. You could get springs, bolts and such in bulk from your local hardware store. But the 1 1/2 to 3 horsepower engines, wheels and steering wheels would be more economical from the manufacturer.

Just look up the items in the Register, call the company and ask how much per dozen. It's as simple as that. Now you have the source for almost everything under the sun.

When you start your business, go to your local Chamber of Commerce and ask about city and state licenses. They don't amount to much, nor do city and state business taxes. Also, a business gives you Federal tax deductions. Your time, materials, electricity, cost of tools and machinery, even the space in your home or shop, are all deductible.

When you're looking for a project in the SURVIVORS, don't be put off by materials hard to get today. Many of the projects call for parts from junk yards of those days. For instance, say you wanted to make and sell the "Merry Hop-Around" to nursery schools (Vol. 8, page 120). It asks for an axle and a Model-T front wheel. Don't look for a Model-T front wheel. Instead of an axle use a steel pipe over which

you fit a larger pipe with a cap, projecting through the bottom board and half way through the top one. Simple.

The dehydrator (Vol. 8, page 125), which should sell very well, gives a choice of lattice, glass or asbestos trays. Forget the glass and certainly the asbestos and go with the lattice trays.

You're not bound by any of those old plans. They're just ideas and designs listing materials, many of which are unavailable today and many more of

which have been replaced by better materials. Improve and substitute.

When you and your buddies have decided on what to make, equip your shop with relatively cheap machinery at first, unless you're already skilled. You might also find that you don't really need that machine or need one with different properties. There's no sense in getting set up with expensive machinery before you're sure of what you really need and know how to use and care for it.

The best source of inexpensive tools and shop machines is Harbor Freight, 3491 Mission Oaks Blvd., Camarillo, CA 93011. Write for their free catalogue. They specialize in warehouse closeouts and sell fairly good quality tools and machinery at the lowest prices. They have an 800 number for orders and pay the freight for orders over \$50.00.

Some of their tools and general equipment is very good and will last. I suggest you trade with them while your funds are limited and until you really know what you're doing.

When you're at the professional stage you'll want the best, the sturdiest precision tools and machinery. Then you'll want to get a catalogue from Grizzley, 1821 Valencia, Bellingham, WA 98226. They have the finest but at pretty high costs. So when you've gotten past ruining machinery, go Grizzley.

In the meantime, it wouldn't hurt to take a free night highschool course in shop or even in business administration. One thing in life you can be absolutely sure of is that knowledge and skill is the key to success.

A most important consideration in manufacturing a product is that anyone with average skill and knowledge can make just about anything, in time. But the key to profit in manufacturing is efficiency in the use of time. If it takes you a week to turn out something you sell for \$100.00, you've made \$100.00 for that week, less the cost of materials.

The difference between the hobbyist-craftsman and the manufacturer, is time. If you want to profit from your skills, time is a luxury you can't afford to waste.

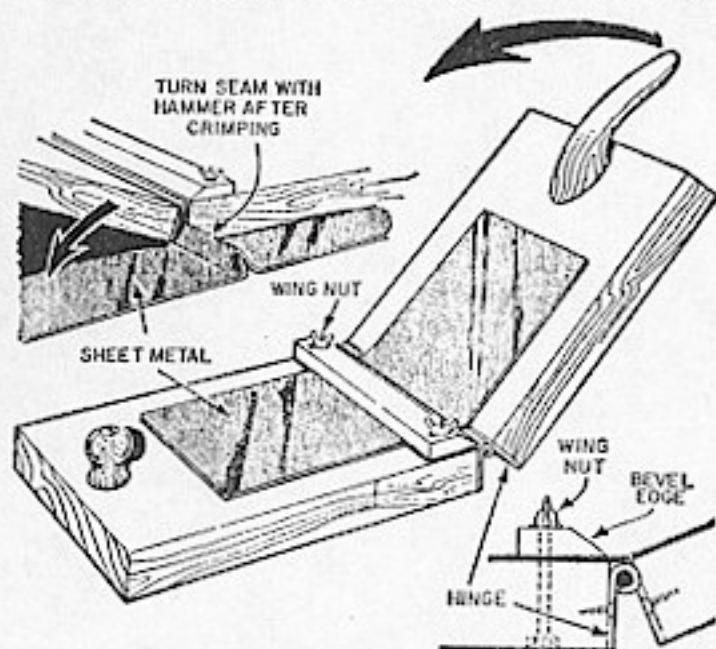
Having two or three friends in the shop, each doing what he does best and fastest will cause two or three items to be completed much faster than if each built a whole unit himself. The hobbyist spends most of his time changing over from one operation to another, whereas the time saved in mass-production methods does not waste motion. When making something for resale at a profit you must learn to eliminate every unnecessary motion.

The following 1939 article, "Getting The Most Out Of Yourself" will help you to practice the conservation of motion. Study it and succeed.

Small Sheetmetal Shop

• Here's a practical metal-working tool that you can hang right above your bench and always have ready when you want it. And you can make it any size to suit the work you want to do.

To bend sheet metal, just insert it under the bar, snug up the wing nuts and draw the handles together. For a lapped seam, make

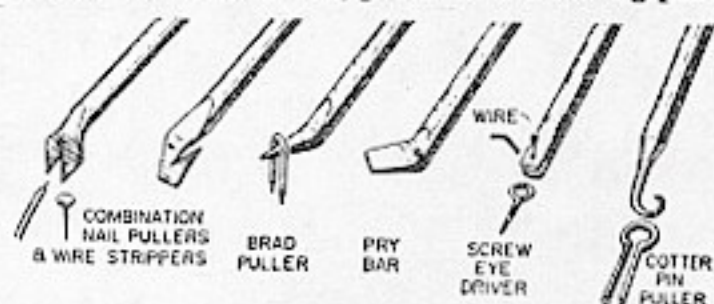


the bends in the same way, and then position the assembled seam under the tool to crimp it between the hinge plates.

Use a number of butt hinges or a piano hinge to join the halves of the tool. Although not necessary, a pair of handles will make the work even easier.

Small Tools from Screwdrivers

• Inexpensive screwdrivers with non-destructible plastic handles and good steel shanks are excellent materials from which to make the special tools needed in your shop. First anneal the part of the shank to be re-worked by heating it to cherry red and cooling it slowly. Then grind and bend it as desired. When finished, polish the working part



of the tool and retemper it by heating it to cherry red and quenching in oil.

Getting the Most Out of Yourself

By
J. J. WENNER

WITH the advent of mass production applied to industry, it became necessary to parcel out the various tasks connected with producing each article of manufacture. These tasks, for sake of efficiency, were reduced to a simple form, and specialized to the degree so the average workman could learn the job in a very short time, and attain a degree of specialized skill far beyond that of the average man having a large number of different jobs to perform. Naturally, the jobs being repetitive, it followed that a science should be developed which had as its prime motive, the further systematizing of these jobs, with a marked increase in efficiency. This science, which has been growing for a period of some thirty years, is called motion study. It is today recognized as an invaluable tool to industry and can be also applied to the home workshop, as well as to our everyday life, with interesting and surprising results. While it is the purpose of this article to give only an insight into the workings and the possibilities of this science, it is hoped that the reader will continue to think along the lines laid down here and apply these findings to his various jobs with a great deal of benefit to himself.

Let's first get a definition of motion study. Motion study is the science of analyzing a job, any job, so as to reduce this job to its most efficient, or best method. You can readily see from the definition that motion study takes in a lot of ground when trying to reduce a job to "the best method." Not only are the actual motions employed on the job taken into account, but numerous other angles are considered.

There is a popular mis-

conception that motion study involves a speeding-up process, and accomplishes greater efficiency merely by making the worker put forth more effort. Actually, motion study strives to reduce the effort required of the worker, and strives in many ways to make him less tired at the end of the day, yet produce to a greater degree. For example, suppose someone asked you to move a large pile of sand to another location and gave you a bucket

and shovel to accomplish the job. At the end of the day, you would be quite tired of walking back and forth carrying the sand. If the next day, your employer provided you with a wheelbarrow, at the end of that day you would be less tired and move three times as much sand as the day previous. You weren't working any harder, but were using your muscles to better advantage. Do you get the point?

One of the first considerations to be made in applying motion study to a job is "How much time should I spend in analyzing the job?" If you use your home workshop as a source of income, you no doubt have had jobs involving as many as one hundred units, the production of these being stretched out over a period of several months. In this case, you would no doubt be justified in spending a week in analyzing the various jobs and building the various setups necessary for carrying out the work in an efficient manner. On the other hand, if you labor in your little home workshop merely for your own pleasure, it is seldom that you will have a job that justifies more than ten or fifteen minutes in analyzing or making the necessary setups. But, fortunately, once the principles of motion study are understood, you can apply them to any activity, if it only lasts but five minutes, with gratifying results.

Another fundamental consideration which you are bound to run into, if not with yourself, at least with someone else whom you are trying to educate

Are you efficient? Do you waste motion, time, energy? Do you plan a job before you begin work? If you want to finish a job the easy, quick, tireless way, this article will help. It contains ideas, that if put to use, will pay profits in time and pleasure

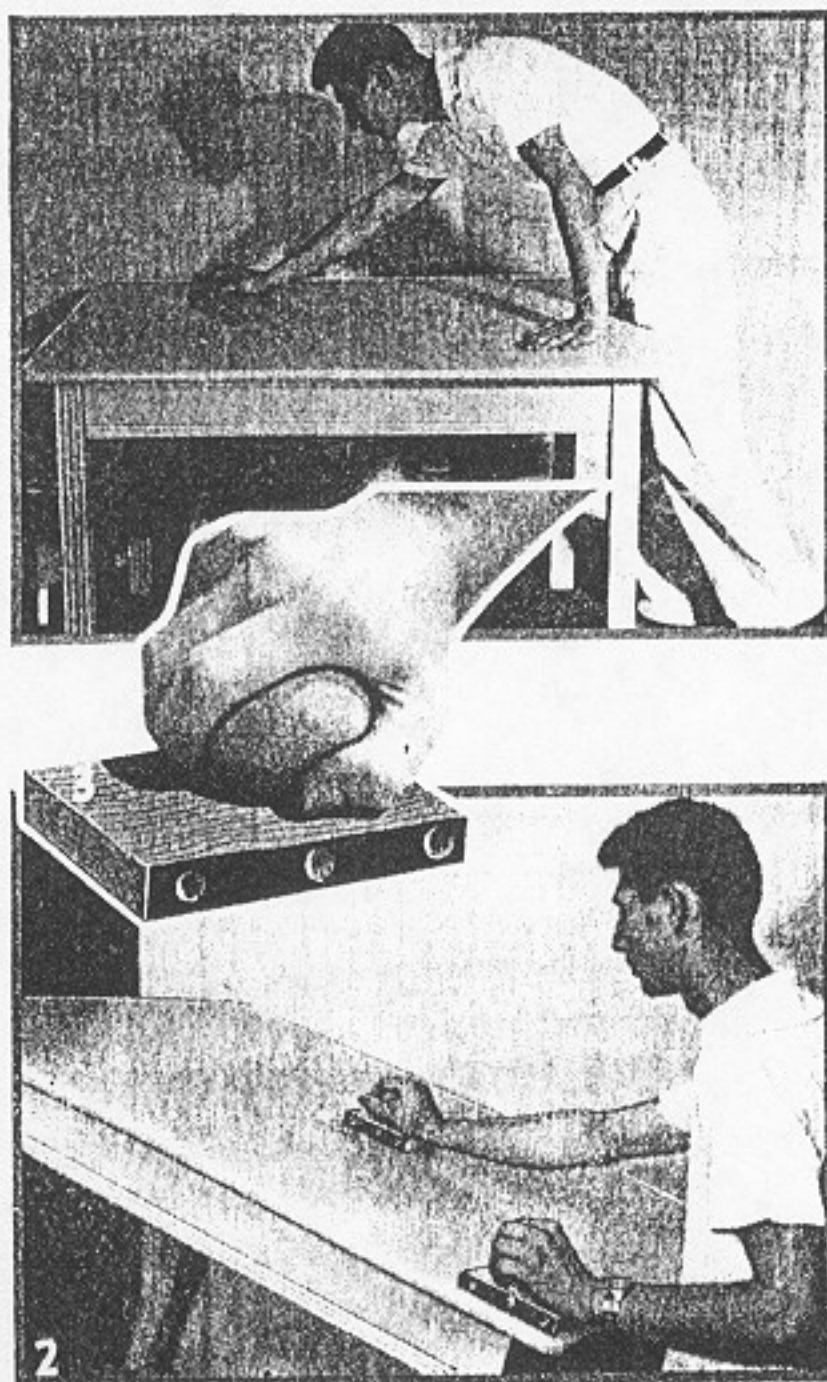


Fig. 1—Conventional method of sanding table top

Fig. 2—The improved method of sanding a table top

Fig. 3—Closeup of the sanding block employed in the improved method of sanding

to a better method of doing a job, is the psychological effect of changing habits. You are convinced, let us say, that you have a better method of doing a job, but yet when applying this method to a task which you, or someone else, have been doing in a different manner for a long time, the new method at first seems so awkward that you, or the other person, begin to doubt whether or not the new method is really more efficient. A single example will show how misleading a new method can be. Suppose I ask you which you could write faster, 16 letters or 8 letters. Of course, you would reply that you could write 8 letters faster. Now suppose you write the following three words, having 16 letters.

Popular Home Craft

Make a mental note of how long it took you to do this. As you practice writing these two words you will steadily gain speed. Now suppose I ask you to write the same words, leaving out every other letter. You would then write

Pplr Hm Cat

This would take you considerably longer to write, and yet you are only writing nine letters. You had to stop and think, and the writing was contrary to the habits you had formed when writing Popular Home Craft. But now practice writing Pplr Hm Cat and you will soon see that you can write the nine letters faster than sixteen. The same principle applies to any other job in which a change of habits is involved.

As mentioned earlier, there are other considerations entering into an analysis of a job, other than the actual motions involved. These are as follows:

1. Is the job necessary?
2. Are the limits too close?
3. Are the best materials, or processes, being employed?
4. Are the conditions under which the job is being performed most satisfactory for the purpose?
5. Is due consideration being given to the next job that follows?

It is usually wise to ask yourself these questions before starting to an-



Fig. 4—Common method of sorting screws, bolts, nails, etc.

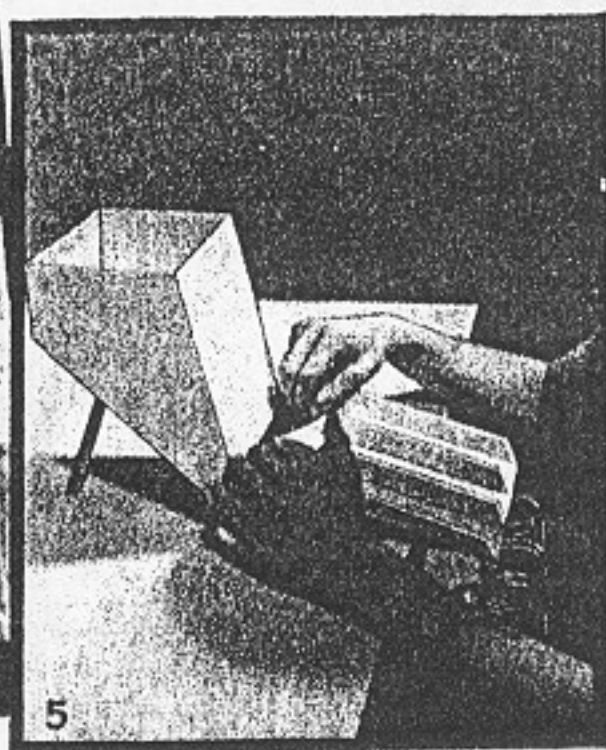


Fig. 5—Improved method of sorting small parts

alyze the job, for as you see by the first question, if the job is not necessary, there is, of course, no profit in analyzing it. An explanation of these questions is in order.

First let's consider if the job is necessary. This question may seem absurd, but how often have you carefully planed and sanded a board only to find as the job progressed that this board was completely covered by another and all your work was really to no avail? You found out too late that a careful consideration of the blueprints would have revealed this before actually making the mistake. You can expect to find similar cases arising as you begin to question each job as it comes up, especially with the more complicated projects.

Are the limits too close? If you are fitting screen doors to your house, it certainly isn't good sense to use the same degree of accuracy as when fitting doors to a Governor Winthrop desk.

The best materials for a job, as well as the best process, usually involve some experimentation to decide. For instance, in making modern rounded corners, sheet metal may be more satisfactory, and much more easily formed, than wood. Likewise, in sawing out curved lines on scroll work, the bandsaw may be much faster and allow you to cut ten thicknesses at once, but a jig saw probably will let you saw five thicknesses with

a greater degree of accuracy and may even eliminate entirely the sanding process which accompanies bandsawing. The over-all efficiency of the job would then be in favor of the apparently slower jig saw. Consideration to all factors must be given when deciding on the best materials or method to be employed.

Are conditions under which the job is being carried out the most satisfactory obtainable? How often have you performed a job in a dark corner of your shop, or even on the floor, simply because you were in too much of a hurry to clean off the workbench? You probably would have been way ahead had you provided a good place to work on a well lit workbench, at which you could stand or sit in a comfortable position, and not strain your eyes in seeing. Then, too, is the job so located that you have to stand in an uncomfortable position for a long time, going through many back-breaking motions, or can you arrange the work so as to sit, or stand, as you prefer, to your work? Here also enters the question of lighting, heating, ventilation, noise, and so on. All these factors can materially affect a worker's production.

Consideration for the next job that follows may make you do things much differently than was expected at the beginning. The example given earlier in which it was decided to jig-saw rather than band-saw in order to save

sanding, illustrates the point of planning for the next operation. If you are drilling holes in blocks which will next be screwed to other members, why not place blocks after drilling in a position to be most accessible for screws, rather than just tossing the blocks into a pile.

Now for the actual motion study. There are given two examples of common jobs around the home workshop. The first group of illustrations shows the common method of doing the job and the second group shows the same jobs after being analyzed. It is to be understood that the second method described and illustrated for each job does not necessarily represent the best method, neither does it represent the most practical way of doing the work. Bear in mind that the examples are for bringing out certain fundamental considerations only.

Figure 1 shows a common job which every home workshop enthusiast has encountered at sometime or other, namely, sanding a table top. The photo illustrates the usual method employed. Now let's analyze this job to see what motions are unnecessary and how we can improve the set-up.

The most obvious mistake is of course the idle left hand. True, this hand will change places with the right hand every so often, but then the right hand will be idle. Since the question of an idle hand will come up so often, a word of explanation is in order. The left side of the body is fundamentally exactly like the right side, but heritage and custom has decreed that we should favor the right hand or foot, and give it the privilege of performing practically all of our important physical motions, such as eating, throwing, writing, handshaking, etc. But train the left hand as carefully as the right and it is just as efficient. For example, if you happen to play a guitar or violin, just try fingering the strings with the right hand, and you'll find you are every bit as awkward as if you tried writing with your left hand.

So when I suggest that you use either hand for any type of motion, don't scoff at my suggestion. Remember that using the left hand or foot is merely a matter of training, and is not to be accepted as a physical impairment. Of course what was said about a right-handed person applies just in reverse to a left-handed person.

Getting back to Figure 1, next notice the long reach. This long reach accounts for the bent position assumed by the sander. For every stroke, there is a slight waist motion and also a shifting of weight from left foot to right. If you

had to do this job all day, you would probably feel as tired in the waist and leg muscles as in the arm.

The sanding block being used is of the conventional type. The man is holding the paper onto the block with his fingers, and applying the forward motion and downward pressure with the heel of his hand. This procedure is quite tiring on the fingers, and since so much pressure is exerted on a comparatively small area, namely, the heel of the hand, the whole hand and forearm soon tires, and it becomes necessary to change hands so as to rest one of them.

Now let's look at Figure 2. Notice first that both hands are in use, each having its own sanding block. At once we have increased the sander's efficiency by almost 100%, since he can now cover almost twice the area in the same time. The procedure would be, of course, to start at the lower left hand corner of the table with the left hand and the upper middle with the right hand. The hands move alternately up and down the table, working from left to right and then

back again when the left hand reaches the middle of the table (measured transversely). It has been found by experience that working the two hands in opposite directions along symmetrical paths lends itself best to natural rhythm and automaticity. For example, notice how much easier it is to hit a punching bag with first one hand then the other, rather than hitting it continuously with both hands at the same time.

Next observe how the table is set up at an angle of about 30 degrees. This eliminates the waist bending motions and also the shifting of the body weight from one foot to the other. The sander now stands upright. Of course his stroke has been shortened so that he is now sanding only one-half the table at a time. Again experience has shown that the most efficient working area is that area directly in front of the operator, which is circumscribed by his arm's length when using the arm as a radius. In other words, you can work best over a distance limited by your natural arm's length, the body being kept motionless.

Figure 3 shows a close-up of the sanding block employed in the second method described. The paper is held to the block with thumb-tacks so as to relieve the fingers of this duty. The handle of this simple tool is a round ball, since this shape fits the hand most naturally and distributes the pressure over the maximum area. As a result of using this type of block, less hand fatigue is experienced, and consequently less rest periods are required. After one-half of the table has been sanded, the table is turned end for end and the procedure is repeated. By employing the second method, the time for sanding the table top would probably be reduced about 55% with much less fatigue being felt

over a long period of time.

For our next example we have a simple job, namely, sorting out screws, bolts, nails, and etc. Referring to Figure 4, we have one of the common ways of doing this job. Suppose we are required to sort out and deposit into jars three different objects from a pile, namely, bolts, nails, and screws. First we pick up all the screws with our right hand, conveying them to our left. After the left hand is full we pour them into the proper jar and then start on the nails. After the nails, the operation is repeated for all the bolts.

Let's analyze the first method, referring to Figure 4. Notice that the left hand is idle most of the time, the right hand doing practically all the work. Next notice that the right hand fingers are picking up each part one or two at a time and carrying them to the left hand. Now when the left hand is full, we drop the parts into the small mouthed jars, usually spilling several over the edge onto the table top where they must be picked up again. Also notice how the parts are all in a pile, necessitating spreading out every so often so as to facilitate picking up.

Now if we had a very large number of the articles to separate from a pile, say a job lasting several weeks, it would pay us to make the special chute shown in Figure 5, which picture represents the better method of doing this same job

after being motion studied. First notice that now both hands are busy, sliding the parts from the flat shelf at the bottom of the chute down the proper guideway directly into the proper jar. We now have eliminated the motion of conveying from the left hand to the jar and have practically eliminated the possibility of spilling the parts while doing so. Also note that now the hands are sliding the parts to the guideways, rather than picking them up as done in the first case. Sliding of parts is always to be preferred and is about 40% faster than picking them up and carrying.

The mouth of the hopper, or chute, is made quite large, so as to facilitate dumping of parts into same. A flat shelf is provided at the bottom of the hopper so that the parts will feed down by gravity and distribute themselves for easy sorting. Notice, too, that both forearms are resting comfortably on the edge of the table. When designing special setups, bear the operator comfort angle in mind. You will be well repaid for a little added work along this line.

The two examples given will probably suggest others of a similar nature which you can now analyze. First, get clearly in mind the fundamental object of the job at hand. Now note the motions which are directly responsible for the execution of this fundamental object. All other motions can be considered as secondary. It is these motions which

you should try to eliminate or simplify as much as possible. With this guiding thought, try your hand at that next job which is inclined to be irksome. You'll be surprised at how quickly the time will pass trying to find that elusive "best method."

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Popular Mechanics August, 1904

BENDING SMALL PIPES.

A method of bending small pipe, the bore of which is not large enough to permit filling it with sand is given in The Model Electrician. The tube was cut off to the length

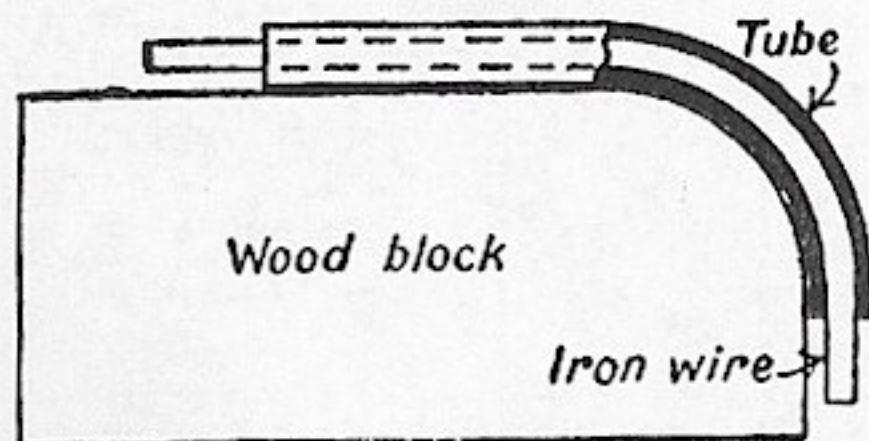


FIG. 1.—MAKING THE FIRST BEND.

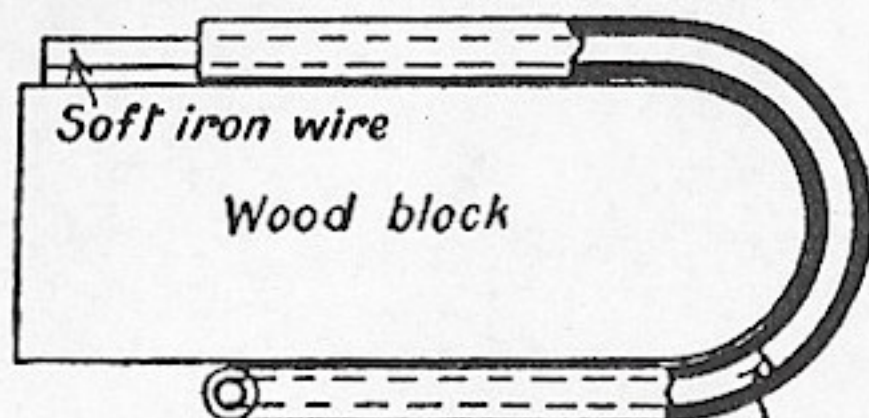
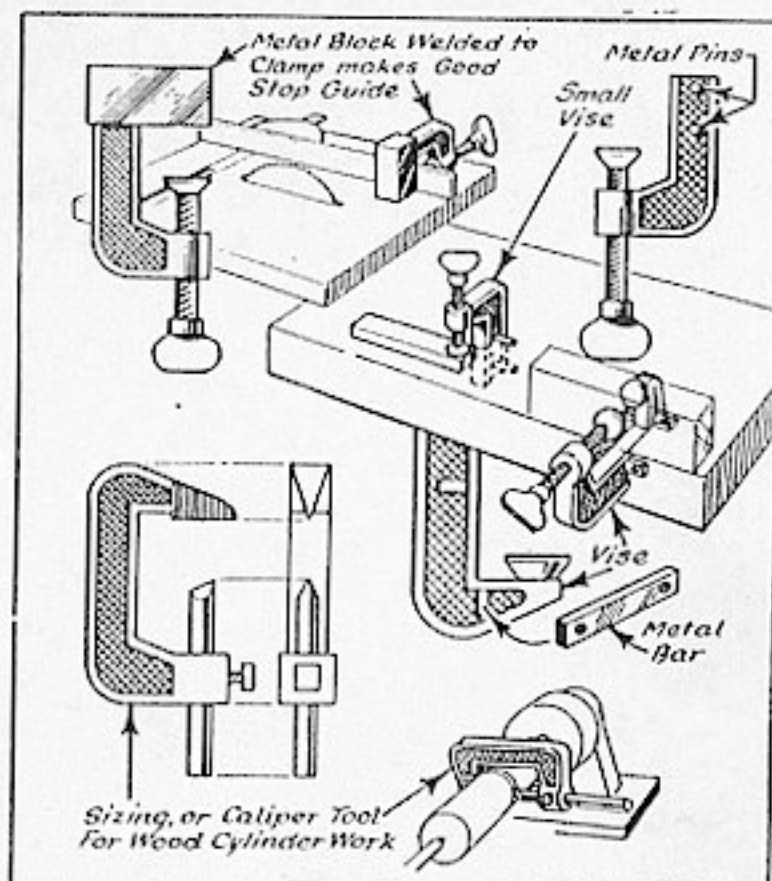


FIG. 2.—THE BEND FOR SYPHON PIPE.

to make a syphon pipe for a small pressure gauge, and a length of small soft iron wire was cut to a little longer than the tube and, the size of wire being just an easy fit in the tube, was then inserted into the latter. The first bend was made at the end where the pipe fits into the boiler, upon a wooden block, and then the wire was drawn out of the curve and the next one bent to shape, and then the wire drawn out. If both bends are attempted without drawing out the wire from the first curve, it will be difficult to withdraw the wire afterwards. In this way small tubes may be bent without damaging them in the least, whereas if the tube be bent without anything in the bore at all, it will surely become flattened somewhere.

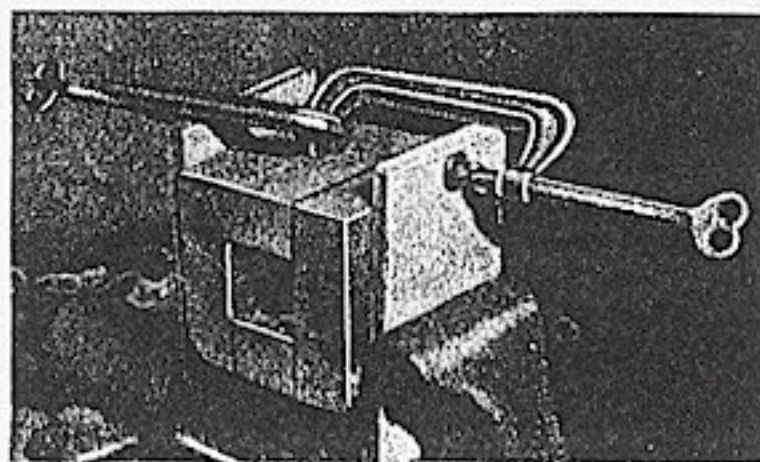
Mechanical Package Magazine, 1932



Workshop clamps make excellent vises, stop guides, or caliper tools when adapted by the methods shown.

Increasing Scope of Clamps

WORKSHOP clamps are useful in dozens of other ways besides their original purpose. They can be made to serve as vises, measuring calipers, and saw guides. The photo below shows how two clamps, linked together, can be used on work which is double the capacity of a single clamp. Two 3-inch clamps will handle work nearly 6 inches wide, and so on. The best plan is to lay boards on each side of the work whose ends extend past the work at least $\frac{1}{2}$ -inch on each side to permit getting the clamps in position.



Doubling the capacity of workshop clamps is simple if you use the method shown above. By linking them together in this fashion, two 3-inch clamps will handle work nearly 6 inches wide. Fitting takes but a moment.

FANTASY & WEAPONRY

By Kurt Saxon

A pistol for the bedroom,
A shotgun over the door,
A 30-06 for reaching out;
You don't need any more.

If an intruder makes it to your bedroom, shoot him with the pistol. If he's trying to break in, use the shotgun. If he is fifty yards or more away and shooting at you, pick him off with the 30-06.

This is the real Survivalist's arsenal; basic, inexpensive, effective. So why all the promotion of rapid-fire weapons? If you aim at a man and don't hit him, he's going to move, and probably shoot you. Banging away in the same general direction is just a senseless waste of ammo. You need practice, not rapid-fire. You also need a realistic attitude, not a fantasy.

But fantasy sells. There is big money in Macho. The more awesome your weapon looks and sounds, the tougher and sexier you look. Girls get off on rapid-fire. It's the Freudian part of the package.

The Rambo Survivalist image being sold to neurotics is making weapons dealers rich. It is also showing the profound ignorance of weapons among the general public.

To know guns, you must understand the three basic methods of shooting; sweeping, pointing and aiming.

Sweeping is with rapid-fire. Its main purpose is to dispatch several enemies before one can shoot you. Such confrontations are unlikely in any actual civil conflict. Raiders don't bunch up. There would be no point to it. Of course, if you are the raider you would have a better chance wiping out a couple and two or three children if you have a rapid fire weapon.

Sweeping is also anticipated in cases of moving targets. Proficiency with the shotgun will do more damage to the moving

target than expert use of rapid-fire.

There is a psychological disadvantage to dependency on a rapid-fire weapon. One tends to sweep or just bang away ineffectually. It is the nature of the weapon and a case of the weapon controlling the man.

An example is a commercial for a TV crime story. One of the heroes bursts into the room and says, "I just had an Uzi emptied on me outside". Obviously, the character with the Uzi swept, did not aim or even point. At least 20 shots and nothing. Of course, it was fiction. But that kind of shooting is becoming acceptable.

If an automatic weapon is shifted one and a half feet, in 20 or more yards, the bullets are spaced several feet apart. You could empty a clip on several people and not hit one. The nut who unloaded several clips of an AK-47 at a crowd of 35 children in Stockton only killed five. What if he had had a rifle and had to aim? What if he had had a shotgun and had to point? Couldn't he see his sweeps were ineffective?

He was crazy but he wasn't blind! He knew how to operate the weapon. But he was psyched up with the glamor image of that weapon. He was not controlling that weapon; it was controlling him.

Another TV segment was on the Gulf. Here were all these troops practicing, banging away at a dune, fully automatic, as usual. I only hope the Iraqis are on full-auto. I wouldn't want anyone to get hurt.

Yet another segment was at a California shooting range. It told how the state had 300,000 assault weapons owners but only 15,000 had registered as ordered.

There were about ten men banging away on semi-auto, as fast as they could shoot. They were all pointing, as they were shooting too fast to correct aim.

I suppose they were all wealthy, as ammo costs a lot. Whatever practicality there might be in such weapons, only the wealthy can afford them.

Watching those men, I could see that their practice was ineffective. The targets were only 10 to 15 yards away. No proficiency can be gained by simply banging away at a stationary target from a distance at which one only has to point.

Watching them reminded me of the reason for the arming of all the American forces with rapid-fire weapons. During the Korean War it was found that only one in nineteen soldiers would fire his rifle. They were mostly uniformed civilians in a no-win war and didn't want to get killed. So they would just hunker down and try to ignore the Chinese. Having Garands, which demanded aiming, put them at risk of getting a bullet in the face.

So by the time the Vietnam fiasco rolled around the boys all had the confidence-giving, noise-making AR-15s. They were effective enough for jungle fighting where one could not aim anyway, even if he knew how to shoot. It didn't matter, however, since the other side had AK-47s; just as worthless. Of course, there were plenty enough bombs and napalm to keep the VC's numbers manageable and most U.S. losses were due to booby-traps. So a rifleman was about as useful as nipples on a boar.

I know it is hard to believe that glamor weapons with all their sound and fury, are more hype than effect. However, if one of their proud owners has it out with any practiced hunter with any rifle, the hunter will win.

Now we come to pointing. Apart from shooting at flying ducks, the shotgun is mainly for pointing. Man-killing shot is from #4 to 00 buckshot. (Single 0 buckshot has 12 .30 caliber pellets per round). The best killing range is up to 50 yards.

The 12 gauge shotgun is the most devastating hand-held weapon. Few people realize how really terrible the shotgun is. The Geneva Convention bans its use in war but police use it. It was also preferred in

Vietnam over regulation arms, even though a soldier's family had to send it to him.

A buckshot pellet does not have the penetrative force of any bullet of equal diameter because it is round and not as heavy as the longer bullet. Buckshot is also fired at lower velocities than bullets.

But they still inflict wounds of maximum size, induce considerable shock and hemorrhage. Also, when two or more pellets hit, their total effect on the victim is as the square of the number of hits, not just an additive progression; that is, two hits equal four times the effect of one hit, three hits equal nine times that effect, and so on. If the victim is hit by three Single 0 buckshot pellets it is the same as if he had been hit by nine .30 caliber Carbine rounds.

For the combat shotgun, it is best to take a hacksaw and cut the barrel down to the legal 18 inches. This gives it a slightly wider shot pattern and makes it a little more maneuverable.

Rapid-fire, semi-auto from an assault weapon has no greater killing range than does the shotgun. And since the shotgun must be pointed, and the shot pattern is wider, multiple hits per target are surer than with any assault weapon.

Next in pointing, is the pistol. Beyond a few feet you want a shotgun or a rifle. Aiming a pistol is possible, but only with practice. Practice, however, has made some pistol shooters as deadly at long range as shot gunners or riflemen.

The American Rifleman article, "Debunking The Debunkers", reprinted in US MILITIA Issue 1, tells what can be done with a pistol. Read it. For the most part, the pistol is for close quarters.

You ought to own a pistol and it should be a .38 Police Special with a six inch barrel. I recommend a revolver over an automatic, since the revolver has fewer parts to malfunction. And if you don't think the .38 has stopping power, you just don't realize what you can do when you practice. You

may have been fantasizing over glory guns, the most popular of which is the .45 automatic. Read the aforementioned article.

Several years ago I was in a Los Angeles gun shop. A plain-clothes officer was at the counter talking to the dealer. The dealer stepped back into an alcove and reached up to a shelf. A shot rang out. The gun the dealer had reached for had fallen butt-first and discharged. Before the sound registered with me the officer had his pistol drawn. Naturally, there was no threat. His action was pure reflex. That cop was fast!

In the same time period, there was a funeral for a police officer fallen in the line of duty. The media covered the funeral and some dummy exploded a bomb outside the funeral home as the attending officers were assembling. The newspaper featured the frame of the newsreel of the explosion. In it was an officer with his revolver half-way drawn out of his holster! Both the accidental discharge and the explosion caught on film showed the reflexes of these men to be a tiny fraction of a second each. So you can believe the examples of speed in the article.

Also, if you practice and so become as proficient as those two officers, both in speed and instinct aiming, you can be sure of a fatal hit before your opponent can even touch his own weapon.

For the .38 revolver, I recommend the six inch barrel over the two or four inch. This is because of the barrel's rifling. The rifling gives the bullet its spin, which keeps it on course. The longer the barrel, the more the rifling and hence the more spin. The more spin, the greater the accuracy. A six inch barrel gives enough spin to guarantee about as much accuracy as you will need when using your pistol.

The glamor weapon among pistols is the automatic, especially the .45. It is heavier, bulkier and more than twice as expensive as the .38. Its main claim to fame is its stopping power. But a well-placed bullet is a greater guarantee of stopping

power than a bullet's size. And as the article shows, speed comes with practice. Reliance in mechanics over skill leads to overconfidence. Many glamor gun fantasizers are going to die when they confront a foe who has mastered his weapon.

You may know of whole police departments adopting .357 Magnums or automatics. Maybe their chief watched too much TV. Again, skill with a basic weapon is better than reliance on mechanics or power. The punk spraying lead is no match for a cop skilled with his .38.

Now for aiming. The reason for aiming is to hit the target at a greater distance than is practical for pointing. A rifleman hits everything he aims at. A macho fool just bangs away with a lot of sound and fury signifying nothing; except the deserved death of the ignorant.

Unfortunately, few people aim today. They have mistaken multiple loud reports for damage. One has but to watch newsreels of Arab-Christian conflicts in Lebanon, closeup coverage of the fire fights in Vietnam, the results of drive-by shootings in Los Angeles, etc., to see that moderns simply are not learning to shoot accurately. The discrepancy between shots fired and clean kills is appalling. Our honored WW II dead are spinning in their graves!

Aside from a shotgun or pistol, one should not own a gun not designed for aimed hits. Anyone who advertises such a gun should be boycotted as a traitor to his country. Those who decry the deaths of little children should shame the incompetents but not spare the sellers of weapons which flatter such ineptitude.

I got a laugh from a news report some time ago. A character named T. J. Johnston in California, an anti-gun-registration-protester, was burning his order to register his assault weapon. His cronies were banging away at some targets ten yards away with more assault weapons. No rifleman would waste ammo shooting at a target that

close.

If he goes to jail he might have time to reflect that one rifleman with an M1 30-06 Garand could wipe out his whole flock. He might also reflect that a well-regulated militia made up of private citizens proficient in the use of real weapons would have no fear of gun confiscation.

Have you ever heard of Sergeant Alvin York? You have probably seen the movie, starring Gary Cooper. York was a conscientious objector. But when his friends were dropping like flies he reacted. A hillbilly, he was a trained hunter from childhood.

He first worked his way around the enemy's flank. He was armed with a 1903 30-06 bolt-action Springfield and a pistol. He killed 20 Germans and captured 132. Of course, few of those captured knew it was a one-man job. The point is, he could shoot! He killed 20 men with one well-placed bullet each. He had no need for rapid-fire. He knew that every time he aimed and fired a man was dead.

Most American and German soldiers at that time, with their bolt-action Springfields and Mausers could also shoot. They had to work those bolts and correct every time they fired. And there were men actually trying to kill them all the while! There was no getting around their having to know how to aim and shoot. No room for fantasy.

Among the best combat rifles ever made is the WW II U.S. M1 30-06 Garand. It is a semi-auto with a 1,000 yard effective killing range. It holds only eight rounds so there is no tendency to bang away at a single target.

However, don't discount the bolt-action rifle. After aiming and firing, the bolt is worked as the gun is reaimed, so no time is lost. Most good military and hunting rifles are bolt-action anyway.

You might be tempted to buy the most expensive rifle. But it is best to buy the most

common, the tried and true, the least flashy.

Pause a minute to reflect; if you were driving cross-country on a very important trip, would you choose a common car or a sports model? Of course, you would look grand in the sportster. But if getting there were the only important consideration, you would want the reliability, and serviceability of your dependable standard model over the object of your fantasies.

The same goes for civilian combat. You may fantasize owning an expensive rapid-fire gun, mowing down raiders with ten slugs in each. It looks great in the movies, but why use 10 bullets where one would do? Besides, raiders won't bunch up and charge. They will fan out, using what cover is available, and you will have to pick them off one by one.

Now, if in your fantasies, you used a 30-06, preferably an M1 Garand, and could shoot, you could make your fantasies pay off. Then, with practice in making every bullet count, you could defend your territory against any number of predators.

So if you must fantasize about weapons, fantasize being a better shot than any thieving parasite. Fantasize putting one well-placed bullet into every looter with the stupidity to set foot in your community.

CHEMICALS

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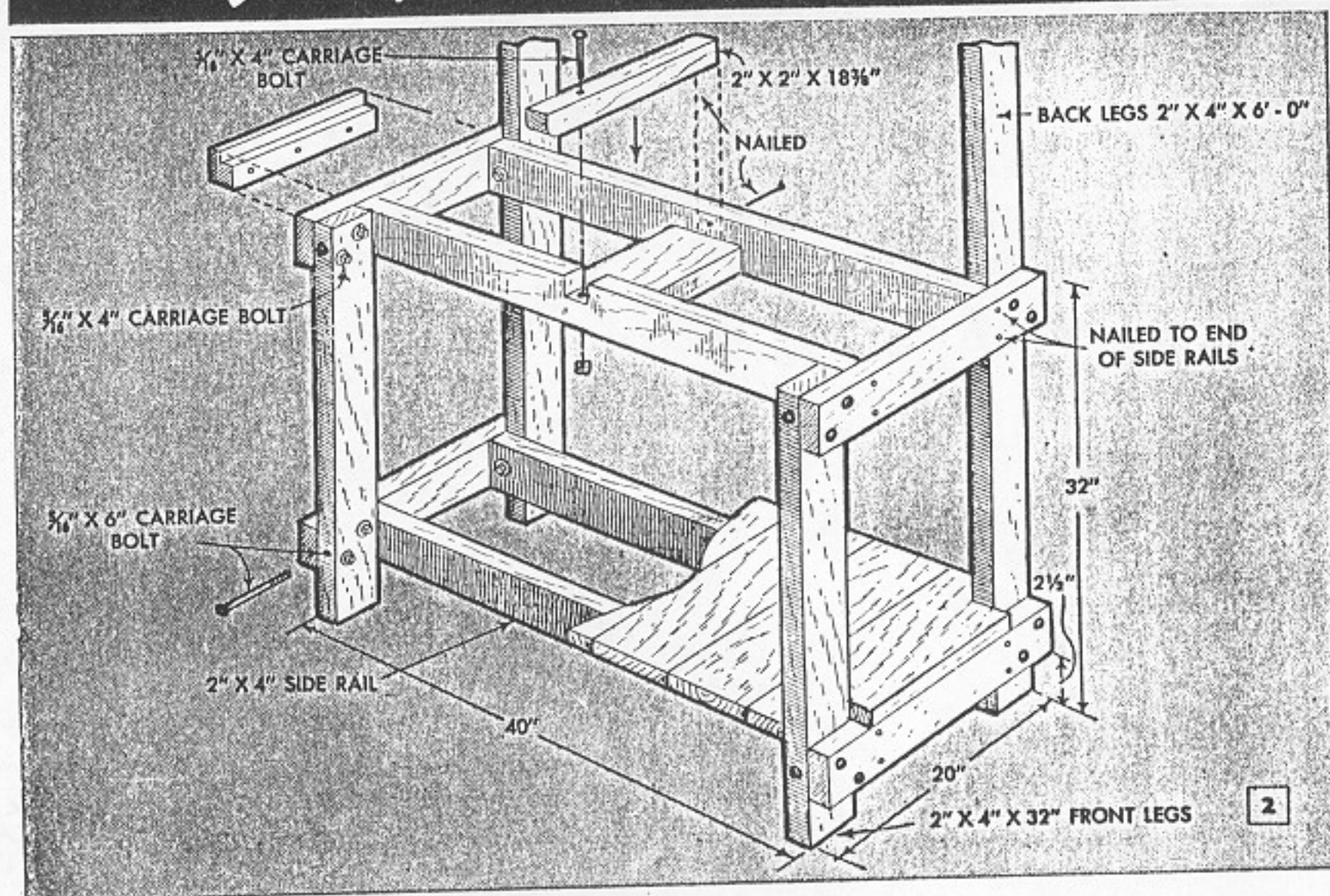
To place an order write or call (619) 948-4150 9AM to 5PM PST M-F

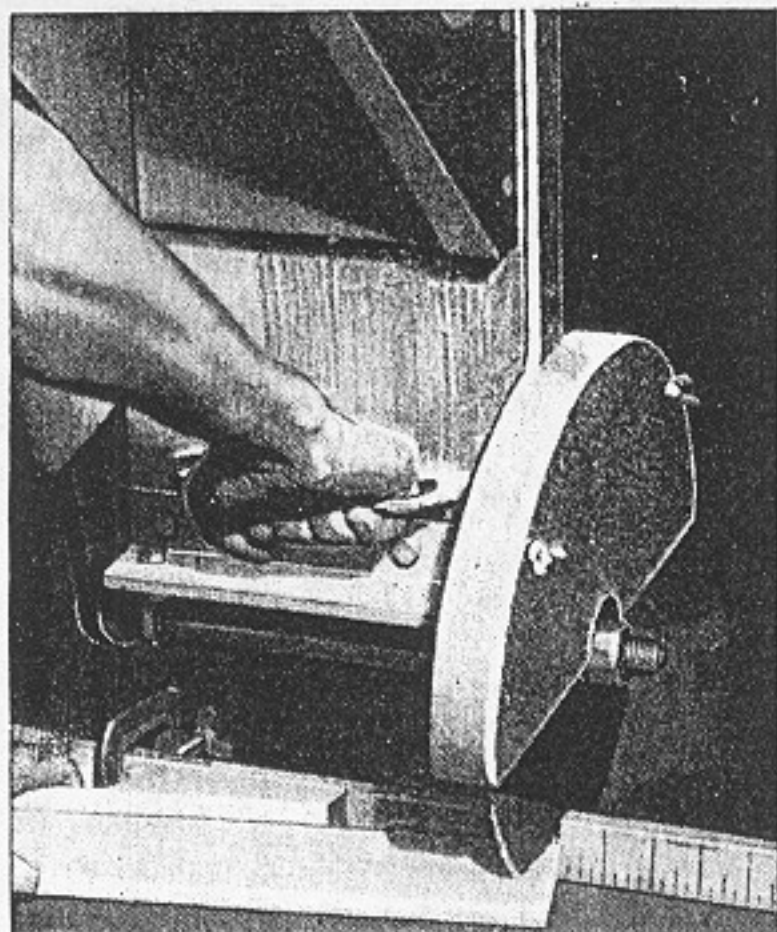
FOR CROSSCUTTING long boards and framing lumber to precise lengths, you can't beat a swing saw for speed and accuracy. That's why experienced home craftsmen, cabinetmakers and carpenters usually build one for use in the shop. The principal units and parts you'll need for the job are a $\frac{1}{2}$ -hp. motor, a ball-bearing saw arbor of the type having a housing cast with bolt lugs, suitable pulleys and belt, a pair of heavy butt hinges and a few straight 2 x 4s and 2 x 6s with which to build the table frame and the back support. Figs. 1 and 2 detail the saw table and frame. Before cutting the stock, note that the table height will be 32 in. plus $1\frac{1}{4}$ in., the thickness of the table top, or, a total height of $33\frac{1}{4}$ in. Some craftsmen prefer a table height of 36 in. on a swing saw. Check beforehand to make sure which table height you desire. Note also that the table-top length is 45 in. and that the saw blade is on the operator's right. Many craftsmen prefer the blade on the left, as it is somewhat easier to see the dimension marks when cutting to pencil lines rather than using the scale on the table fence. This will require a saw arbor with a left-hand thread.

The back legs of the table extend to 6 ft. in height as in Fig. 2. First, cut the legs and the end and side rails, or stretchers. Be sure that all parts are cut square at the ends and to the lengths specified. Assemble the end members with glue and bolts as in Fig. 2 and check both assemblies for squareness before the glue dries. Then set up the frame with the side rails in place and place bar clamps across the top and bottom end rails, using one clamp at each corner so that the frame can be drawn together tightly before drilling the holes for the 6-in. carriage bolts. Use waterproof glue in the joints and, when the frame has been glued, clamped and bolted, check for squareness.

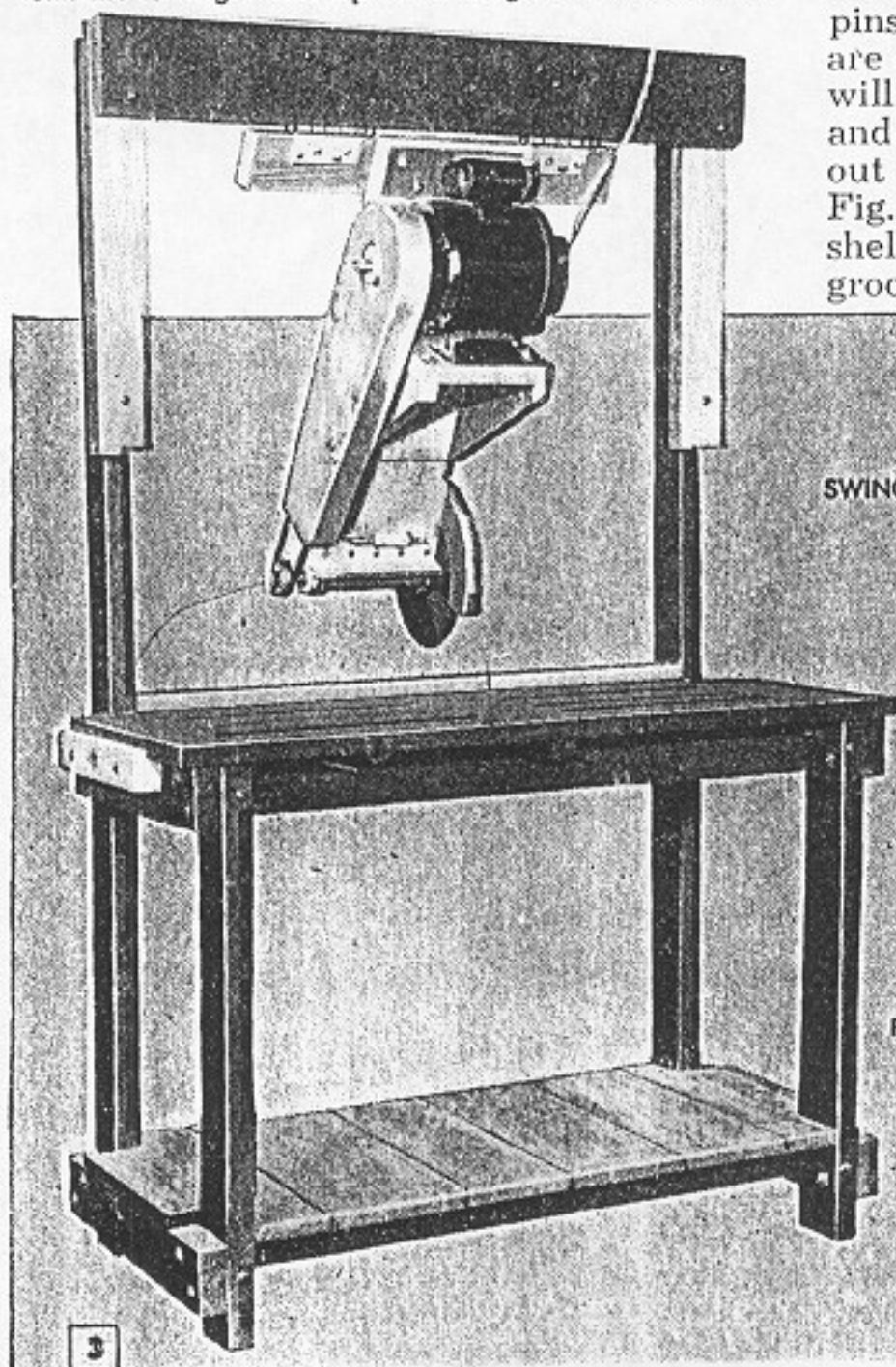
The table top, Fig. 1, is a simple edge-gluing job with the joints doweled. To form the slots, bandsaw both edges of each of the inner pieces, and one edge of each of the outer pieces to a depth of $\frac{1}{2}$ in., each cut being 14 in. long. Start the cuts in on a $\frac{1}{2}$ -in. radius, run straight for 13 in., then out to the edge on a $\frac{1}{2}$ -in. radius. When the table strips are assembled, the cuts will form 1-in.-wide slots with rounded ends, permitting sawdust and chips to fall through to the floor. Although the table length is given

for Your Home Workshop





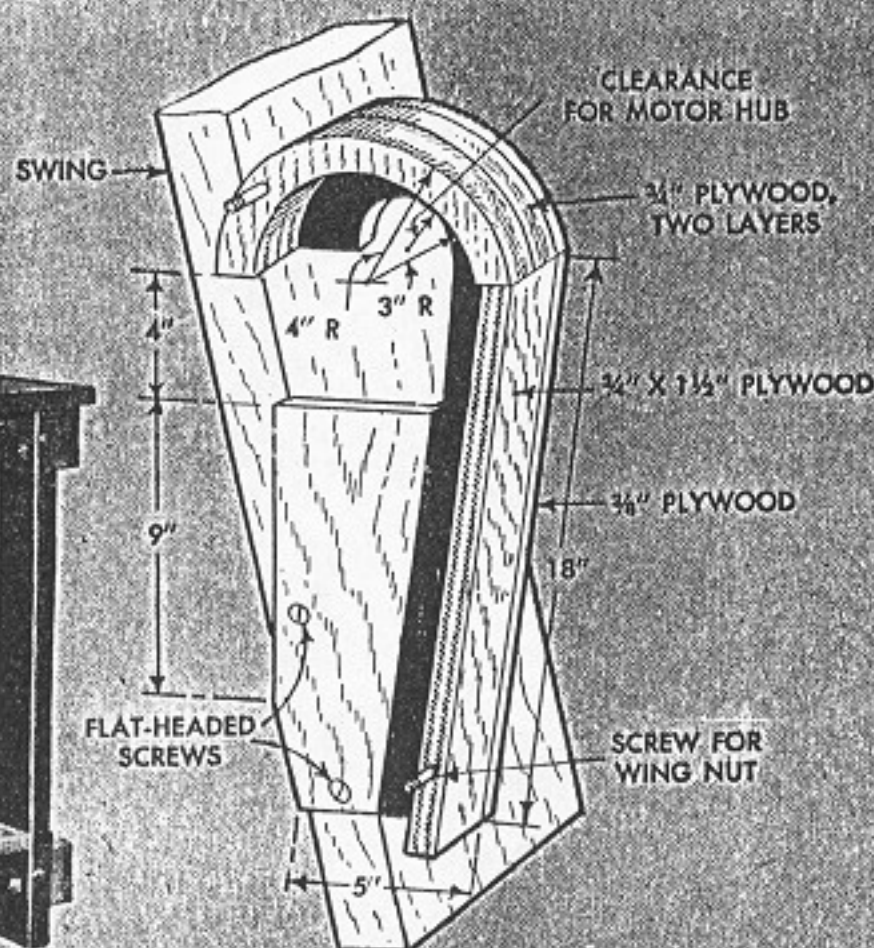
By using angle blocks clamped against the fence, you can make angle cuts up to 45 deg. on narrow stock



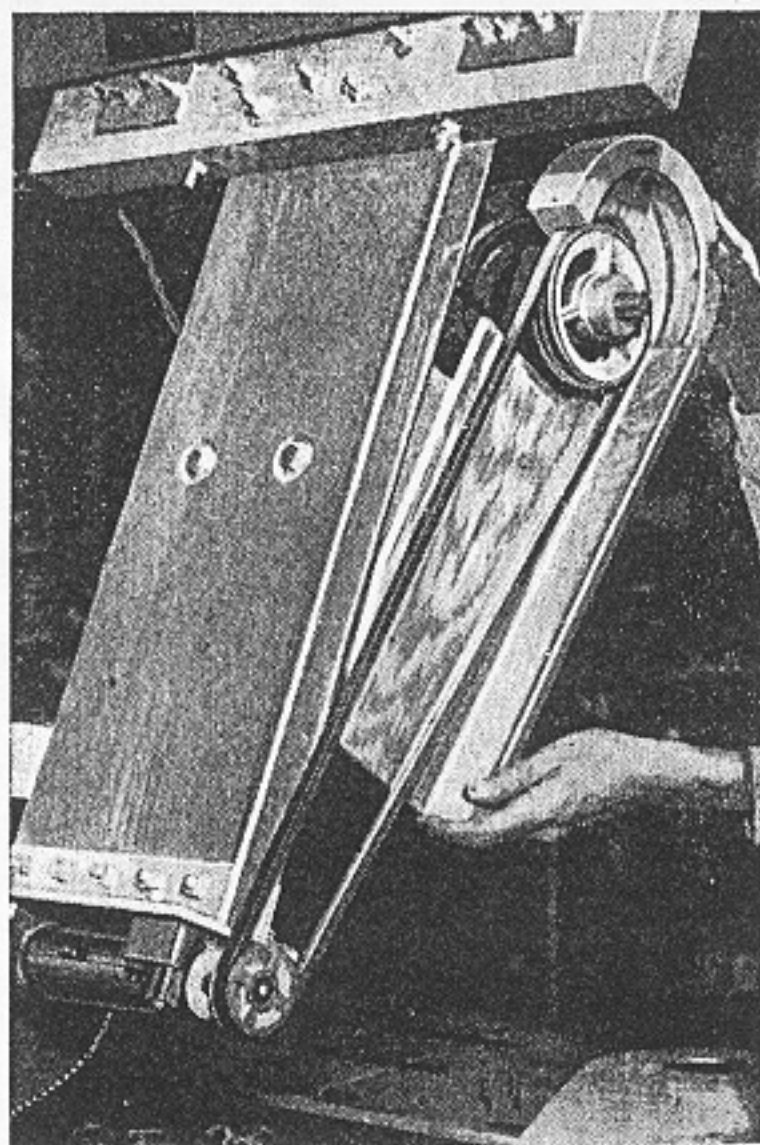
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here as 45 in., it can be made any convenient length up to 6 ft. by using the same general construction and thickness of material. The table top is attached to the frame with spaced wood screws driven in countersunk holes. If desired, the holes can be filled with wooden plugs after driving the screws. Note in Fig. 2 that the table top is supported at the center by a 2 x 2-in. cross member bearing on a 2 x 6-in. spreader glued between the rails. The cross member is notched through the front rail as shown. Sand the table top smooth and apply a thin coat of orange shellac. Finish with wax. The lower shelf, Fig. 2, can be omitted if desired.

The swinging column, motor shelf, guard and arbor mounting are detailed and pictured in Figs. 3 and 4. The top of the swinging column is attached to a cross member, and this is hinged to the horizontal support which is bolted to the top ends of the back table legs as in Fig. 1. Before attaching the hinges, cut out and drill backing plates from $\frac{1}{8}$ -in. flat steel so that the hinges can be attached with bolts as in the sectional view, Fig. 1. Lay the hinges on an anvil and indent the hinge eyes with a prick punch so that the pins will be a tight press fit when the hinges are assembled with the parts in place. This will prevent any play in the swinging arm and also will prevent the pins from working out while the saw is in operation. Note in Fig. 4, right-hand detail, that the motor shelf rides on a key, or guide, fitting in a groove cut on the back face and that the bolt

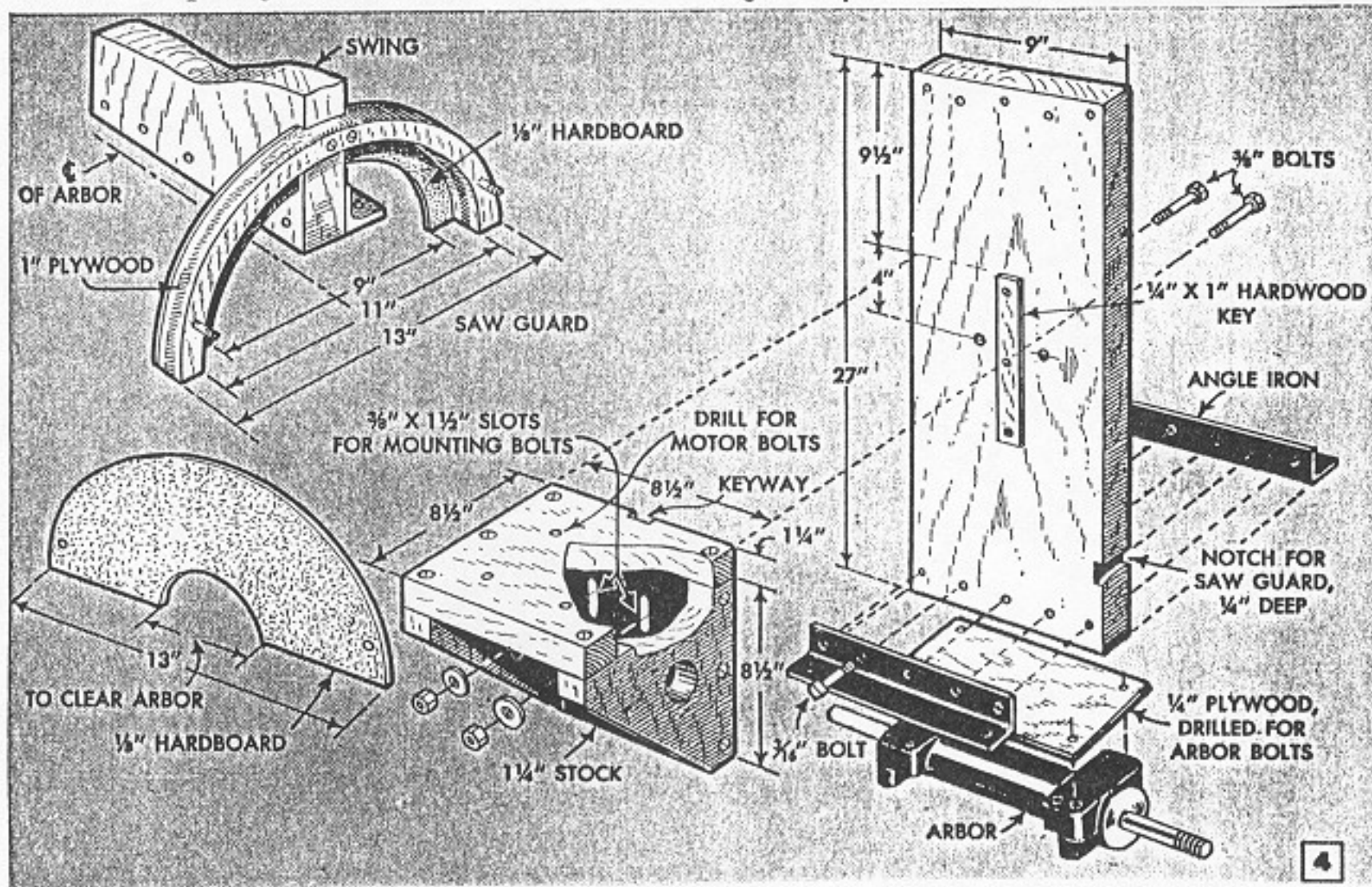


holes are elongated so that the motor may be adjusted to give the correct belt tension. Two pieces of angle iron are bolted to opposite sides of the column at the lower end to form a mounting pad for the saw arbor. Because of slight irregularities of the cast arbor housing, it's a good idea to insert a piece of $\frac{1}{4}$ -in. plywood between the arbor and the angle-iron pad as in the right-hand detail, Fig. 4. It is essential that the saw arbor and motor shaft be as nearly parallel as it is possible to make them. As dimensioned, the parts accommodate an 8-in. blade. After mounting the motor and arbor, make the belt and blade guard, following the details in Figs. 3 and 4. Now, mount the swing unit in the frame and locate at the proper height in relation to the table top by adjusting the supporting cross member of the frame slightly up or down. When properly adjusted for height the blade will cut a groove in the table top about $\frac{1}{8}$ in. deep. Screw the fence in place and make this first cut through the fence and across the table top. Then remove the fence and mark it in $\frac{1}{8}$ or $\frac{1}{16}$ -in. graduations to the right of the saw cut. Note in the right-hand detail in Fig. 1 that the swing support is blocked out from the uprights. These blocks are not necessary for cutting stock up to 10 in. wide, but for full capacity of about 13 in. they will move the unit forward just the right distance. For correct blade speed with a 1725-r.p.m. motor, use a 5-in. pulley on the motor and a 2-in. pulley on the arbor.



Belt guard is built up as a unit before attaching to swinging column. Note relative size of pulleys

Details below show the construction of column and angle-iron pad on which the saw arbor is mounted

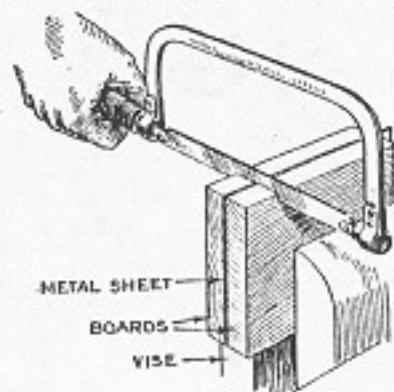


POPULAR MECHANICS

August 1931

Wood Clamps Aid in Working Sheet Metal

Lightweight sheet metal, such as is used in making stage shields, may be easily drilled, filed or cut if clamped between two boards as shown. By this method the sheet metal is held rigid, so that holes will be without burrs, and clean straight cuts can be made. — Ross J. Plaisted, Brecksville, Ohio.



Rosebud Ice Cubs — Freeze a tiny rose bud in each cube to float in special summer drinks.

A drink with all the essential nutrients.

- 1 banana (peeled)
- 1 apple
- 1/2 lemon
- 2 tbs. sweet cream
- 2 tbs. honey
- 2 tbs. crushed walnuts

Throw all this in a blender, apple seeds and all, mix and drink!

Celery juice revitalizes stomach and is terrific for the nervous system.

Carrot juice is a rich source of vitamins A, B, C, D, E, G, and K for stamina and vitality.

Cucumber juice is good for the skin, heart, hair, gums and blood pressure.

Many vegetables such as soy beans and most nuts have far more usable protein per ounce and per dollar than meat does.

Homemade mayonnaise:

Combine 4 tablespoons cornstarch and 1 cup hot water
Cook until clear.

Combine 1 egg, 1 teaspoon mustard, 1 1/2 teaspoon salt, 2 tablespoons sugar, 3 tablespoons vinegar, 1 cup oil.
Beat with cornstarch mixture until smooth.

Cover and refrigerate.

Keeps 2 months.

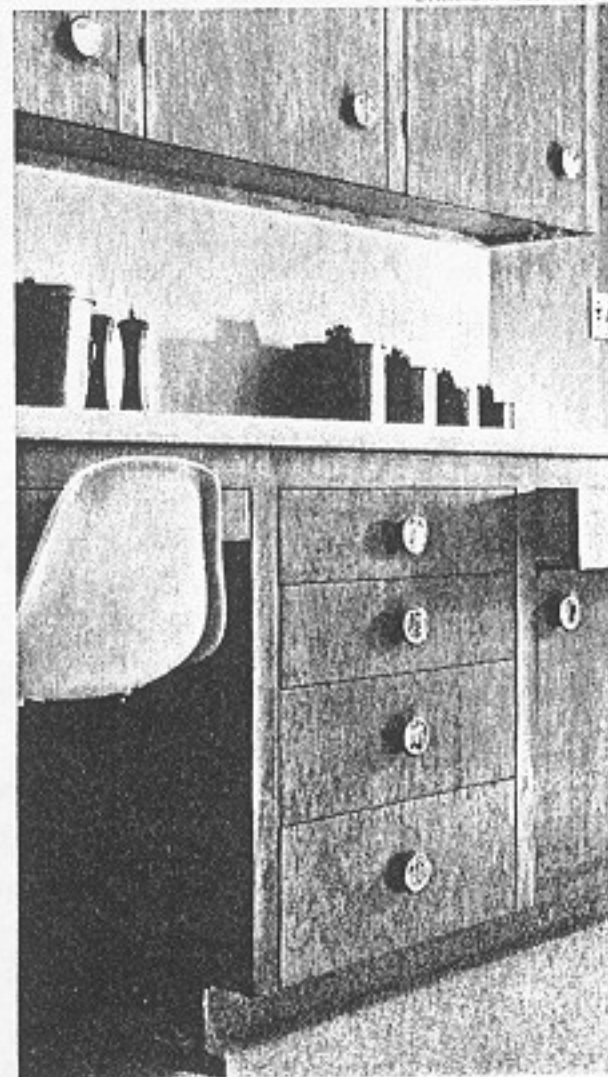


Hardwood pulls, 2 1/2 and 3 inches wide, form bases for mosaics. Hollowed faces are stained only; remaining wood is stained, shellacked, varnished, to match cabinets

Door and drawer pulls...in mosaic

SUNSET MAY 1962

DARROW M. WATT



Colorful fruit mosaics, against gray tile ground, are handsome on birch cabinets. Large pulls are below, small ones above

Each drawer pull and cabinet pull in the kitchen glimpsed at left—and there are about 40 in all—is a miniature mosaic: bright colored fruits worked in bits of Venetian glass tile. They were designed and made by Mrs. Robert DeLiban of Menlo Park, California, to add color and pattern to her newly remodeled kitchen.

The bases are standard maple knobs (available for 20 to 30 cents each, depending on size), their centers turned down on a lathe to the tile depth. A silicone coating applied to the mosaic portion after the grout is dry makes it waterproof and stainproof.

The simplest way to work such small detail is to draw the design on the wood and cut each tile to fit, selecting tiles of uniform depth. (Venetian glass tile varies in depth and may vary in color from sheet to sheet, so buy more of each color than you think you need.)

If you use waterproof, clear, fast drying cement, you need not glue an entire knob at a time. Cut and place tiles, working with several at once so you can have alternate choices in fitting background pieces (the same color on all pulls). When space is filled, cement each tile in place. After cement dries, clean with acetone, and grout several knobs at a time.

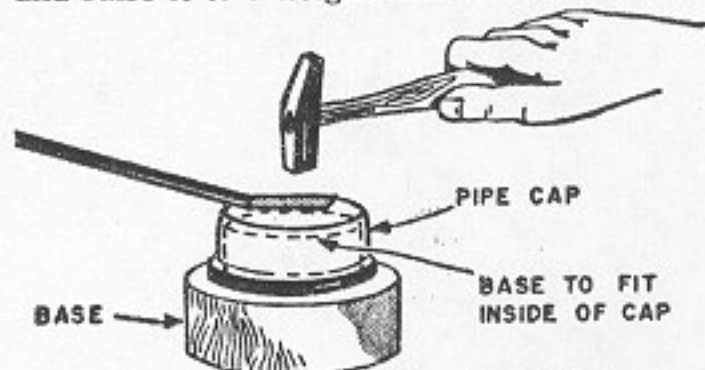
QUERY No. 4996. — "I wish I had a Recipe for a Man's Pie — that is, for the kind of pie a man enjoys and that is not so common and usual as apple pie, cherry pie, raisin or mince or a host of others. I want to serve it at a high tea for my son's graduation from high school."

Macaroon Custard Pie

Cream four tablespoonfuls of butter, work in two tablespoonfuls of flour and add to a cup of hot milk over fire. Stir until it boils, then remove from fire, add one-half a teaspoonful of salt, one-half a cup of sugar, and four eggs, and with a large egg-beater — or, better, an electric beater — beat the mixture, and beat and beat until the whole is very thick and close-textured. While beating sift in one-half a cup of macaroons that have been heated in the oven, cooled, crushed and sifted. Pour the whole into a glass pie tin lined with rich, flaky crust and baked just enough to crisp the crust on the outside. Now cook in a very slow oven, 275 to 300 deg. Fah., until the custard is firm, and serve cold with a big spoonful of strawberries crushed with powdered sugar as a sauce for each portion. Fresh peaches, chopped and sweetened, or cut-up fresh figs likewise sweetened, may be used instead of strawberries, and whatever you use we warrant the pie will be found luscious-de-luscious.

Pipe Cap Is Bench Anvil

• A 1½-in. or larger pipe cap can be used as an anvil for light work. Mount the pipe on a base turned or glued-up to fit inside the cap and raise it to a height that allows room for



your fingers alongside of it when holding the work. Polish the top of the cap if it is to be used for metal shaping, or leave it as is for ordinary nail straightening and riveting.

Wire Straightener

• A lot of used wire can be salvaged in a little time with this straightener that handles many sizes of wire. Drill a ⅛-in. hole through

Popular Mechanics April, 1904

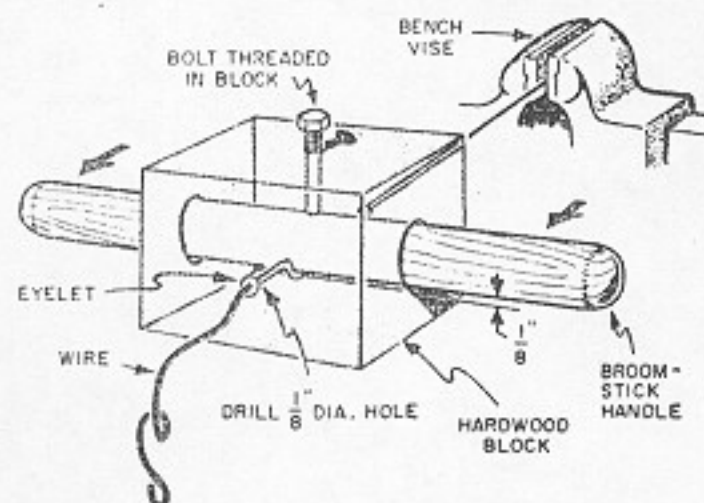
HOW CASTOR OIL IS MADE.

Castor oil is made principally in California, Italy, Mexico and India, but most extensively in California. There are two distinct processes of extracting the oil from the seed, i. e., expression and decoction. While the latter process is adopted in Italy and India, the California manufacturers, and most of the Mexican manufacturers, obtain the oil in the following manner:

After gathering the seed in the fall of the year, they are placed in drying furnaces for an hour or so, for a sufficient time to soften the seeds, as the greater percentage of the oil contained in a seed can be obtained when the seed is soft. After they have been removed from the dryer, they are placed in the press, similar to a cider press, and the seeds are crushed. The oil runs into a large bowl directly beneath this press and is mixed with about an equal portion of water and boiled for one and one-half or two hours—thus precipitating the albumen and other impurities. When cool, there will be a thin scum on top, which is skimmed off. The water and oil are then separated, sometimes by running the water off and sometimes by 'balling' out the oil, which is placed in the 'sun tanks' (tanks of metal exposed to the sun), where it bleaches for eight or ten hours, and is then removed to the store-room, where it is placed in barrels, carboys, etc., ready for the market. Some of the trees in California reach a height of fifty feet, and the seeds from one tree contain as much as fifteen gallons of pure oil.

In more northern latitudes the castor oil plant rarely grows higher than three feet, and is used for ornamental purposes, while in warmer countries it becomes a tree.

a block of hardwood. Then drill a hole ⅛-in. larger than a piece of broomstick at right



angles to it. Drill another hole from one edge to meet this one and turn a coarse-threaded machine bolt into it. With the bolt loose, thread the wire through the hole and around the stick. Then clamp the end of the wire in a vise and pull the ends of the broomstick.

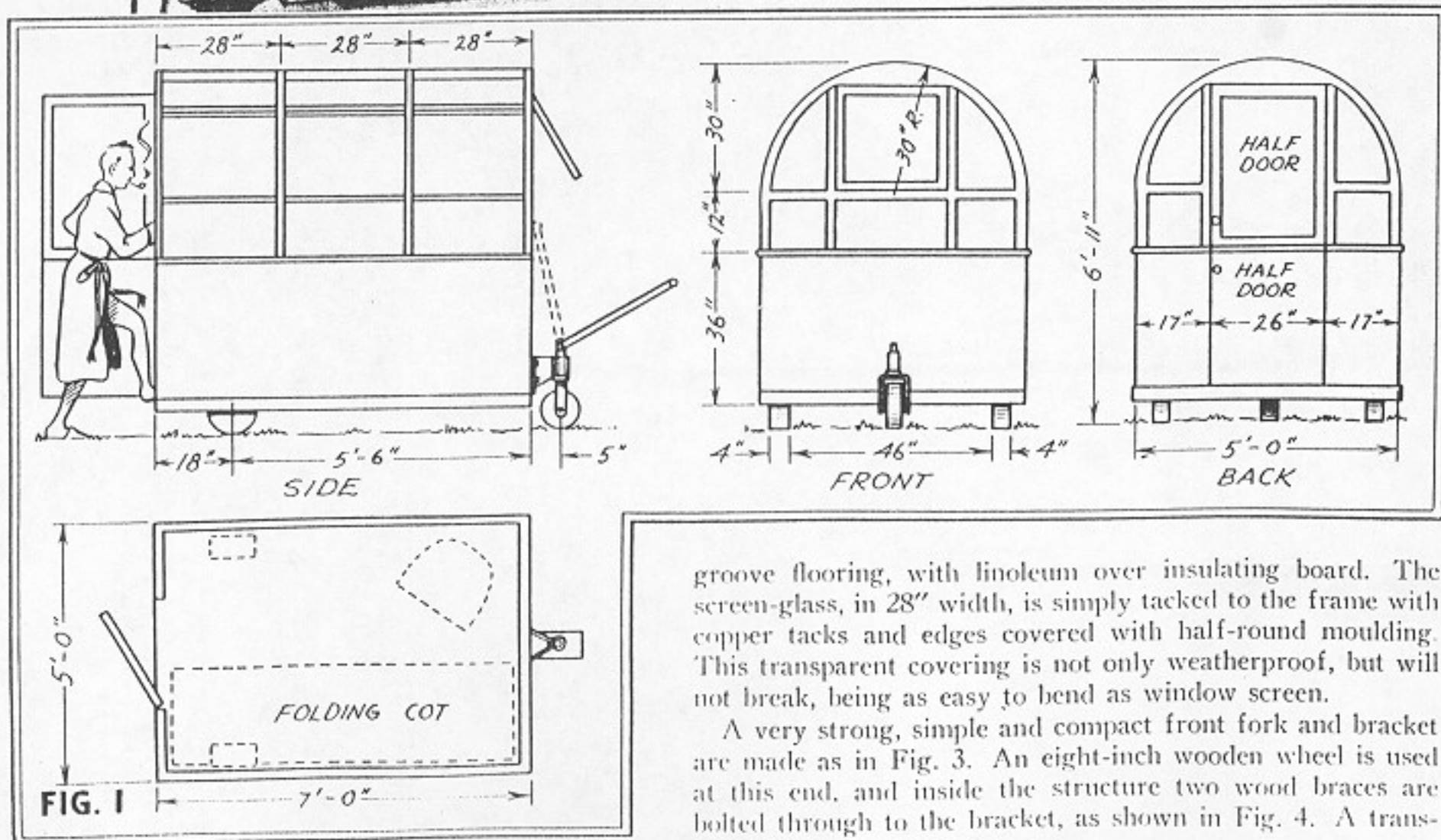
Portable Solarium

HI SIBLEY

THIS light-weight sun-room on wheels can be used for acquiring a tan; as a warm, healthy play-room in cold weather and as a greenhouse in winter. Being covered with a patented screen-glass which admits ultra-violet rays it will be of definite benefit to the human skin. Insulation in front and around sides assures protection against cold winds.

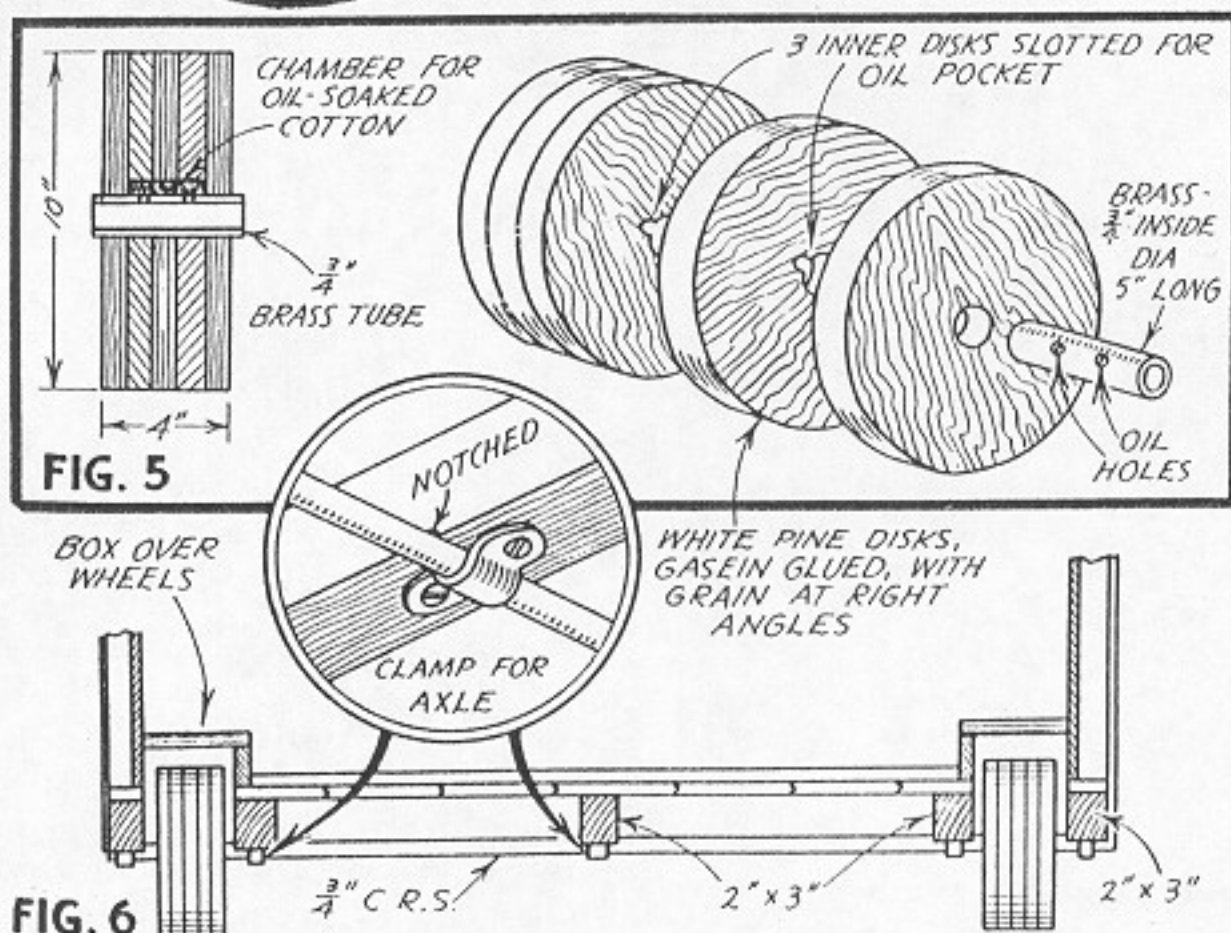
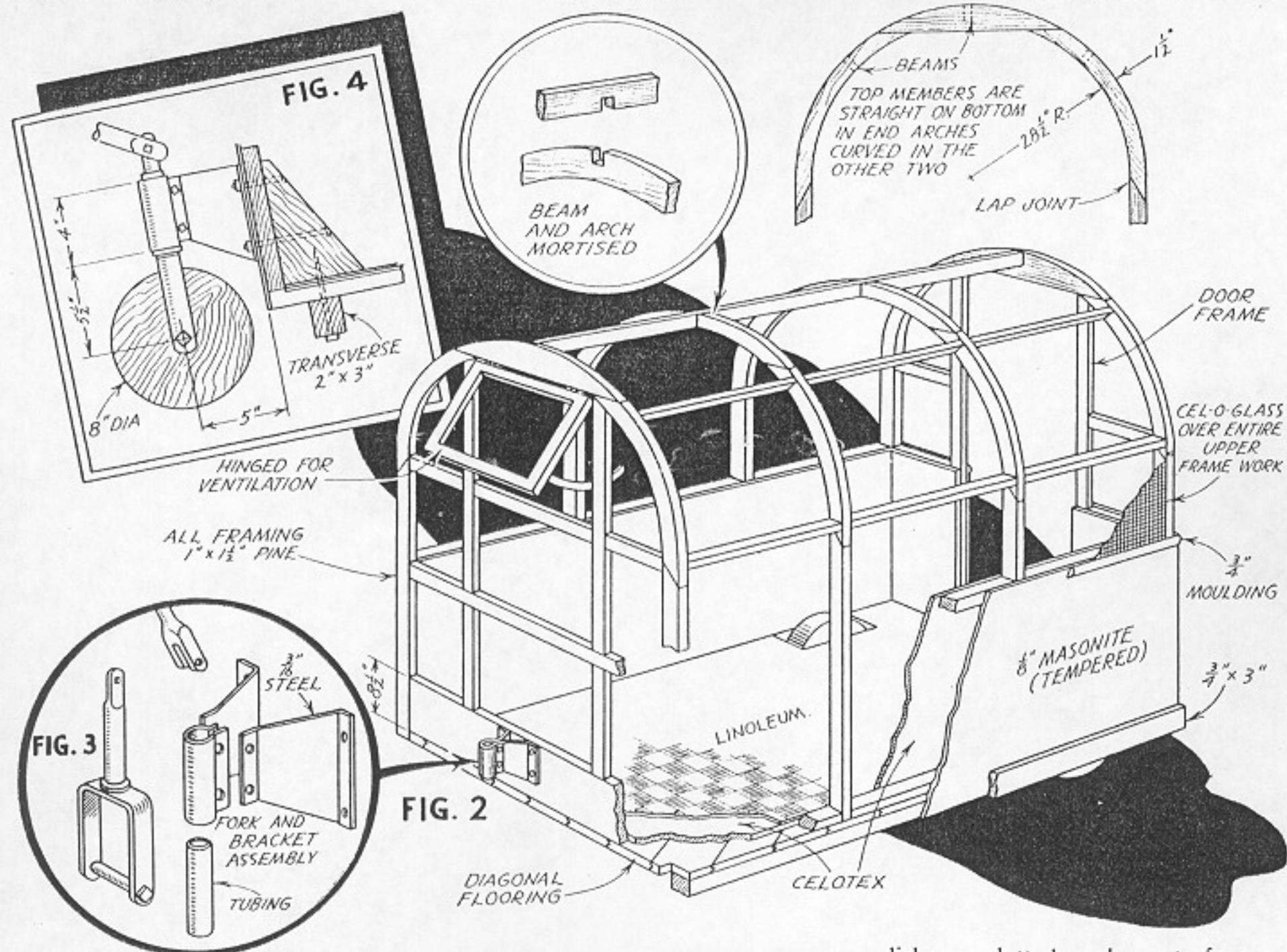
General dimensions are given in Fig. 1, and you will note that entrance is in the rear. Half doors are provided so that the upper portion can be opened for ventilation, while a hinged window in the front end permits circulation through the structure. Construction of the curved roof frame is quite simple as the arches are assembled in three hand-sawed pieces, with lap joints casein-glued and screwed together. They should be laid flat on the floor in assembling, and details are shown in Fig. 2 (at the top). The lower portion of the structure is covered with $\frac{1}{8}$ in. hard pressed board on the outside, and $\frac{1}{2}$ in. insulating board on the inside.

The floor consists of five two-by-threes and diagonal tongue-and-



groove flooring, with linoleum over insulating board. The screen-glass, in 28" width, is simply tacked to the frame with copper tacks and edges covered with half-round moulding. This transparent covering is not only weatherproof, but will not break, being as easy to bend as window screen.

A very strong, simple and compact front fork and bracket are made as in Fig. 3. An eight-inch wooden wheel is used at this end, and inside the structure two wood braces are bolted through to the bracket, as shown in Fig. 4. A trans-



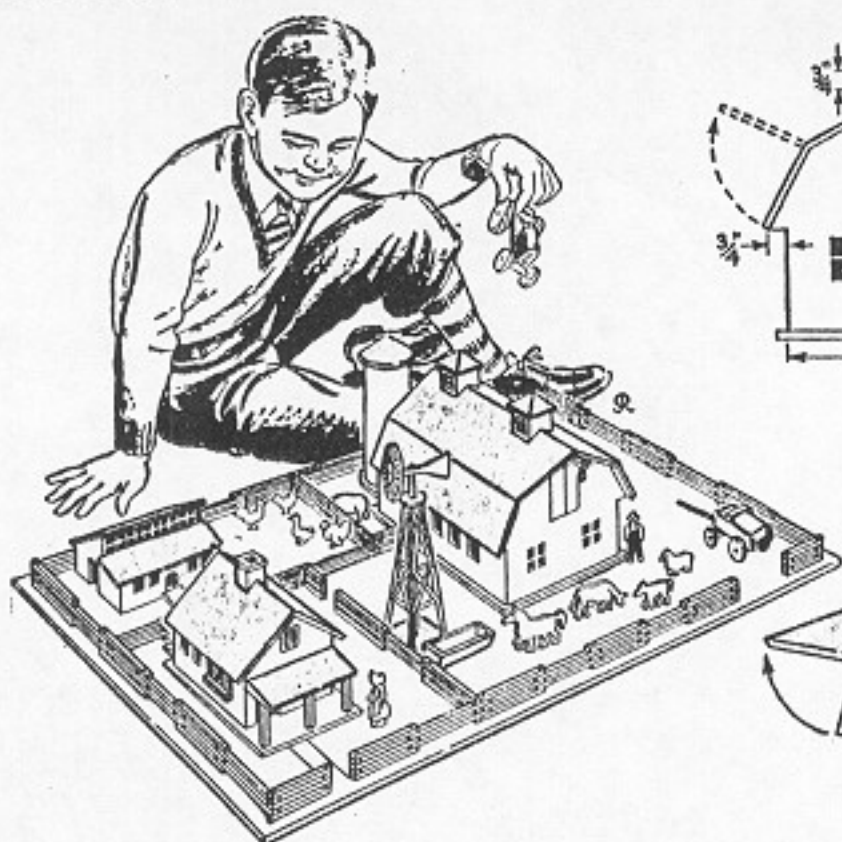
verse two-by-three is used at this end. Inexpensive but durable wheels are made by gluing together five white

pine disks with the grain at right angles to prevent splitting, and trued up on a lathe, Fig. 5. The three inner

disks are slotted as shown to form an oil pocket for cotton. The hub is a brass tube with oil holes as illustrated. This type of wheel is entirely satisfactory where no prolonged towing is required, and is intended for driveway and lawn.

The rear wheels are mounted on a 3/4" cold rolled steel axle as illustrated in the sectional view, Fig. 6. Inside, they are boxed over.

A folding cot, a book table and an easy chair can be accommodated without crowding and otherwise it can be made very inviting. It will be an ideal playroom for children, keeping them off the cold ground and protected from wind, yet having the benefit of wholesome sunshine. To use as a green-house, simply tow to a sunny spot, put in shelves and install two or three electric heating elements under them, protected from moisture above. Even without the artificial heat it will make an excellent cold frame for starting plants early.

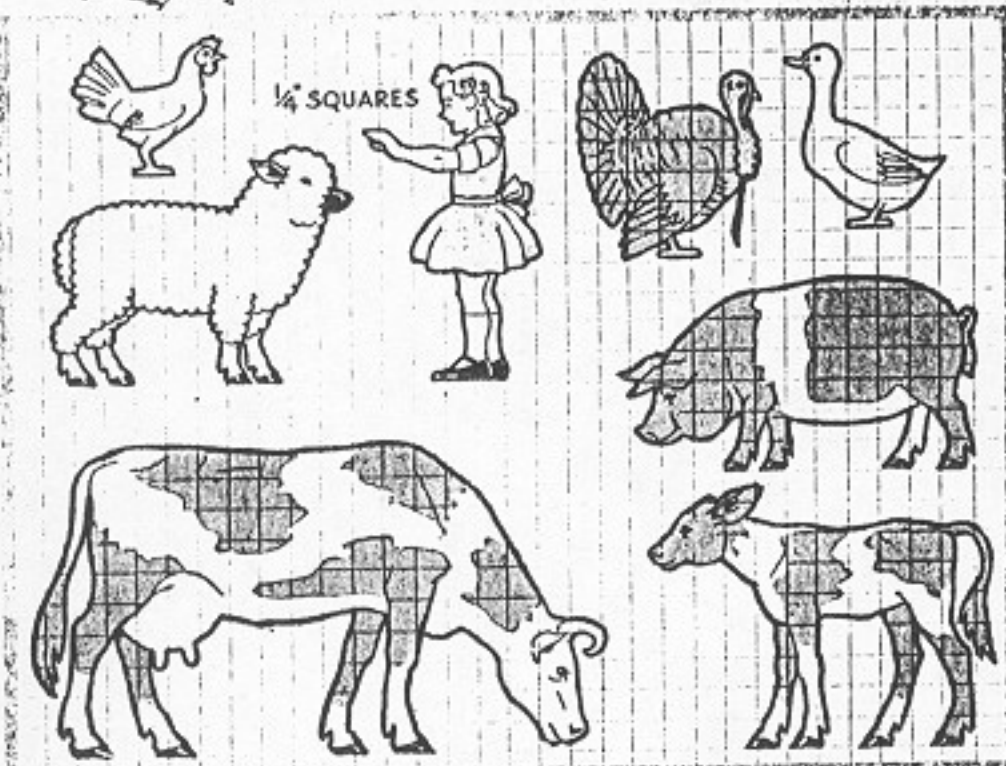
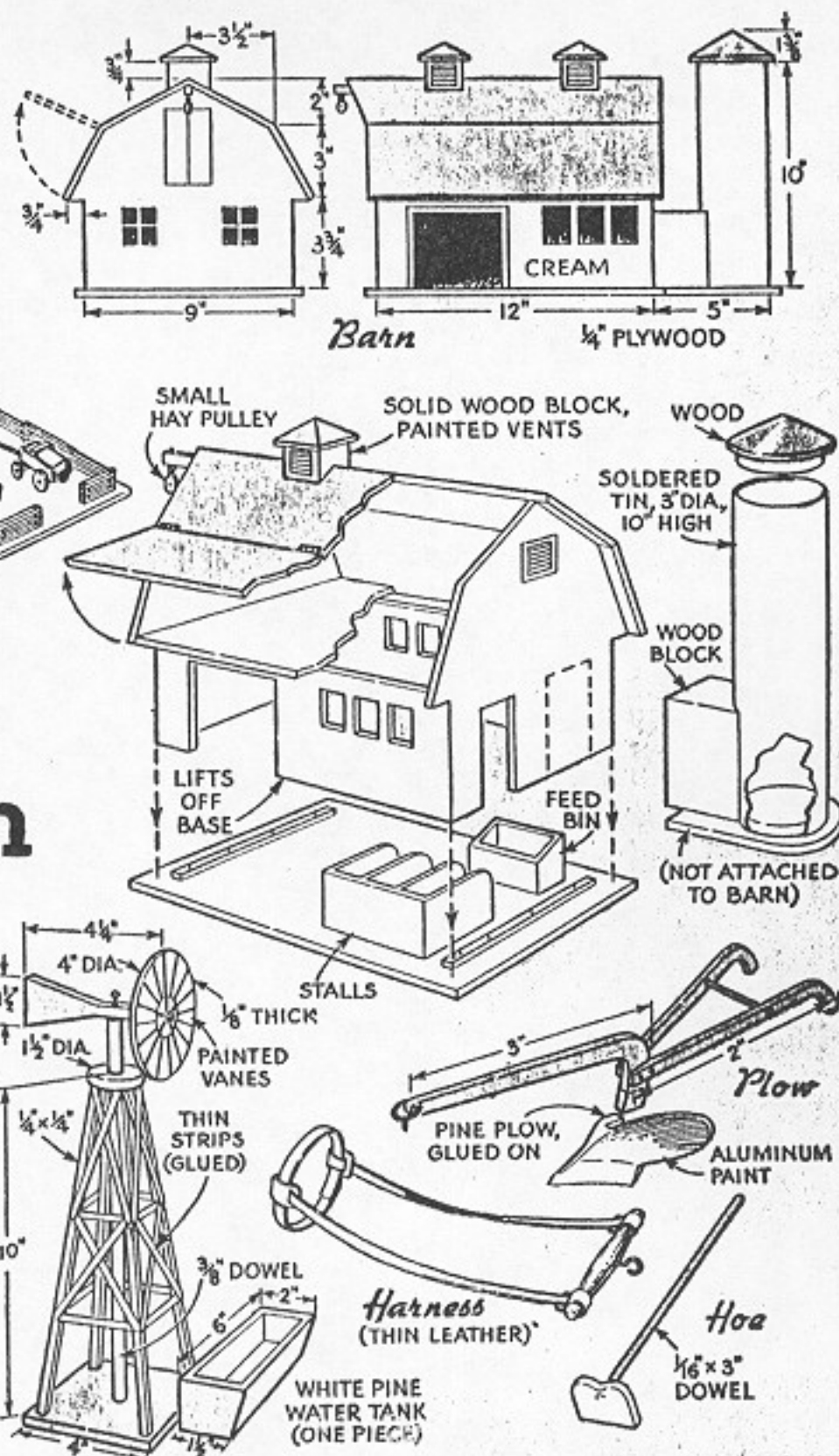


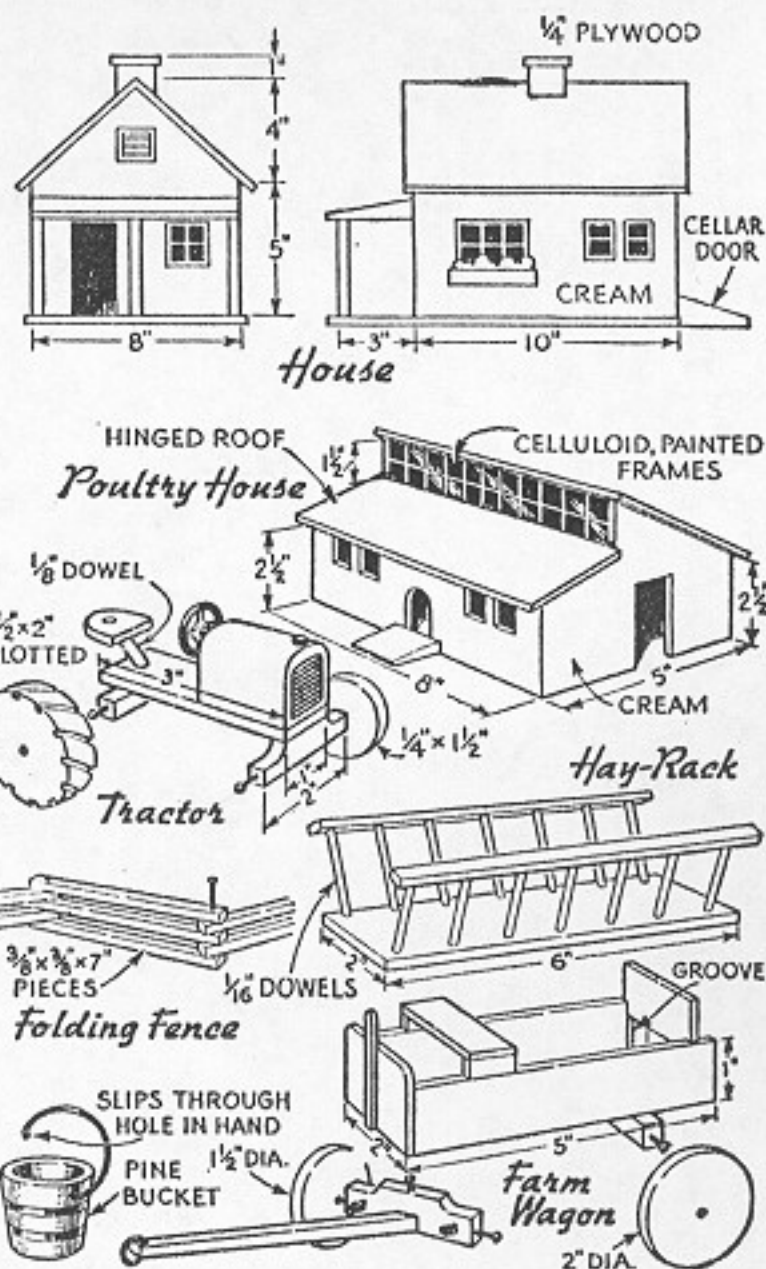
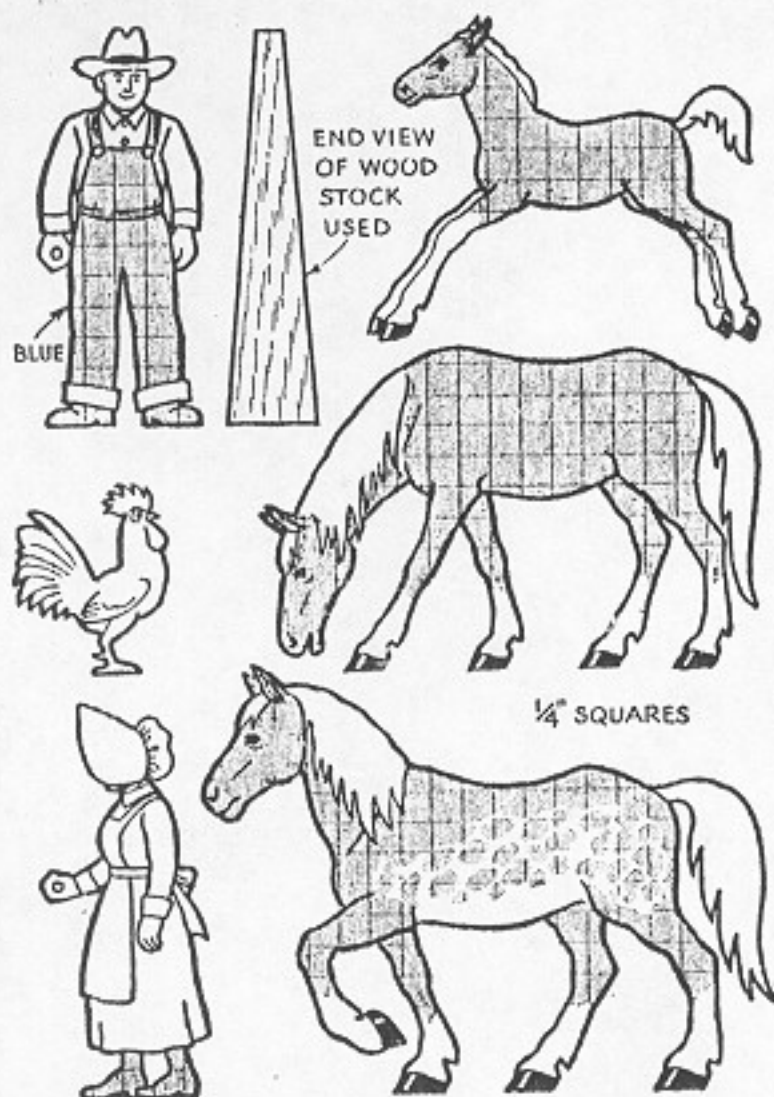
Toy Farm

IN THIS toy farm the center of interest is the big barn, which is made to lift off the base so that a child can arrange the tools and tractor to his taste, and put horses or cows in the stalls. One gable has a hay window with beam and pulley. The fence, which folds up when not in use, can be made in as many sections as required.

Small metal tractors may be bought, but one can easily be built of wood as shown except the steering wheel, which can be taken from a discarded toy. The hay rack and farm wagon have identical running gear. The plow frame can be made of hardwood, with a combined plowshare and moldboard shaped from white pine. Paint the share and moldboard aluminum, the tongue black, and the handles red.

Figures and animals will stand alone when sawed from wedge-shaped material. The man and woman have holes drilled in their hands to receive various small tools, a halter rope, or the handle of the milk pail.



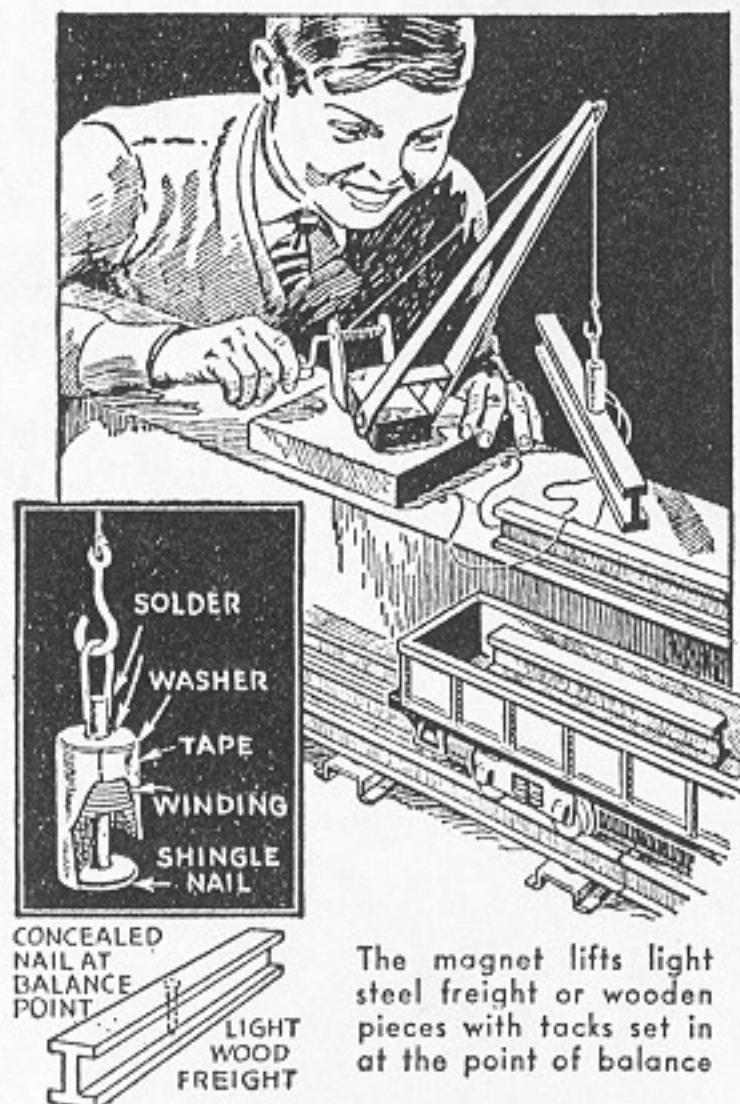


Miniature Electromagnet Loads Model Train

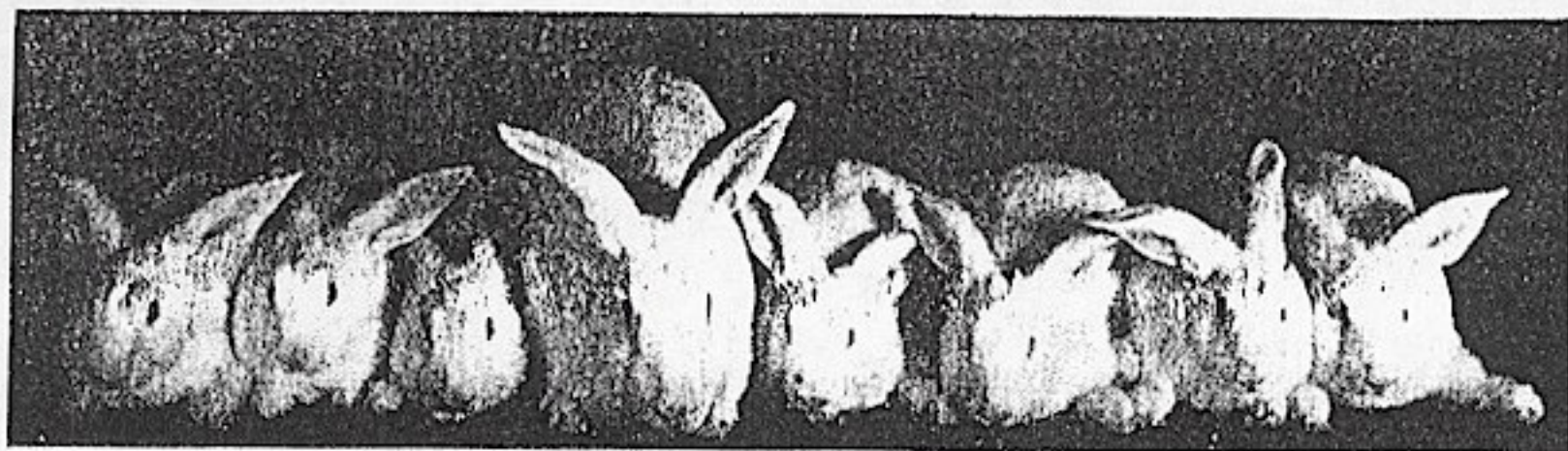
A SMALL electromagnet for loading freight on a model train may be made from materials which nearly every experimenter has lying around.

The core is a shingle nail with the point cut off. A small washer, made from a disk of sheet metal the same size as the nailhead, is soldered on the nail 1" from the head. A loop of wire is also soldered to the end of the nail for attaching the magnet to the cable of a crane. Fill the part between the washer and the head by winding on even layers of any available small magnet wire, such as No. 34 enameled. Leave the ends of the wire long and cover the coil itself with a layer of cellulose tape.

One dry cell, which may be concealed under the freight platform, will operate the magnet. If suitable lightweight "freight" made of steel is not available, imitations can be made of balsa wood or pine and painted, but drive in a tack or small nail at the balancing point so that each piece can be picked up by the magnet.



The magnet lifts light steel freight or wooden pieces with tacks set in at the point of balance



When choosing a breed, give consideration to the New Zealand White. Here is a doe with her healthy, vigorous, good-type litter.

Raising Rabbits for Meat

SCIENCE AND MECHANICS SUMMER, 1943

Patriotic and thrifty Americans can grow their own unrationed meat at little expense right in their own backyards.

By MARTHA G. MORROW

Photos and plans by Fish and Wildlife Service,
U. S. Department of the Interior

RABBIT meat, and unrationed rabbit meat at that, will be served this year for the first time on many tables, and patriotic and thrifty Americans will raise rabbits to keep the wolf from the door.

Some people consider white rabbit meat as great a delicacy as frogs' legs. Certainly it deserves to be more popularly used than hitherto.

meat. What's more, you will like the meat, too.

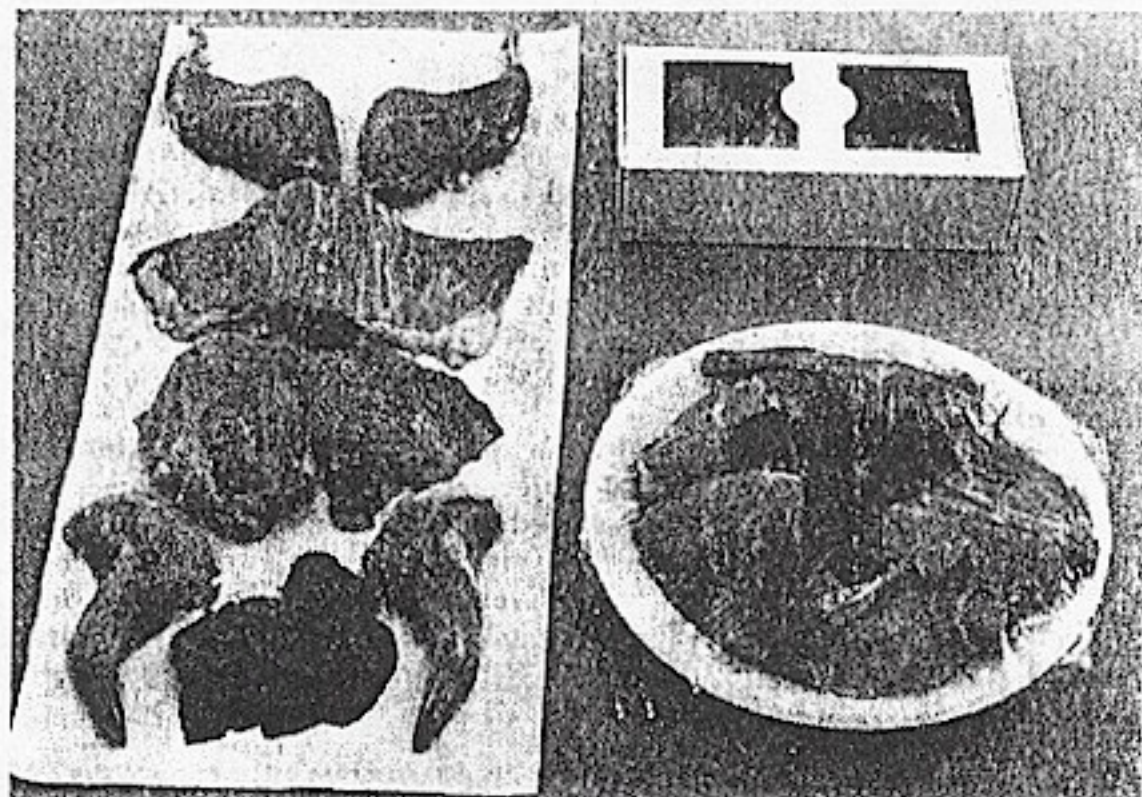
You don't have to live on a farm in order to raise rabbits. Any backyard where chickens are permitted will do. All the equipment you need is a little feed, table scraps, and several packing boxes which you can easily remodel.

If you are considering raising rabbits for eating, you would probably choose a New Zealand, Chinchilla, or one of the other better-known breeds. The lovely albino rabbits are the most popular, and consequently are often hard to buy.

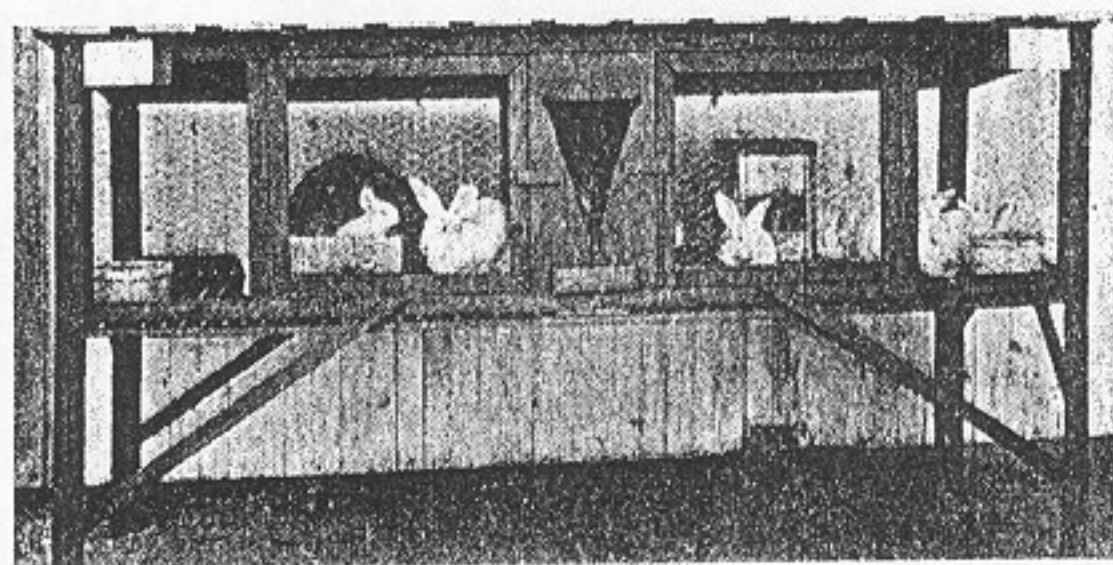
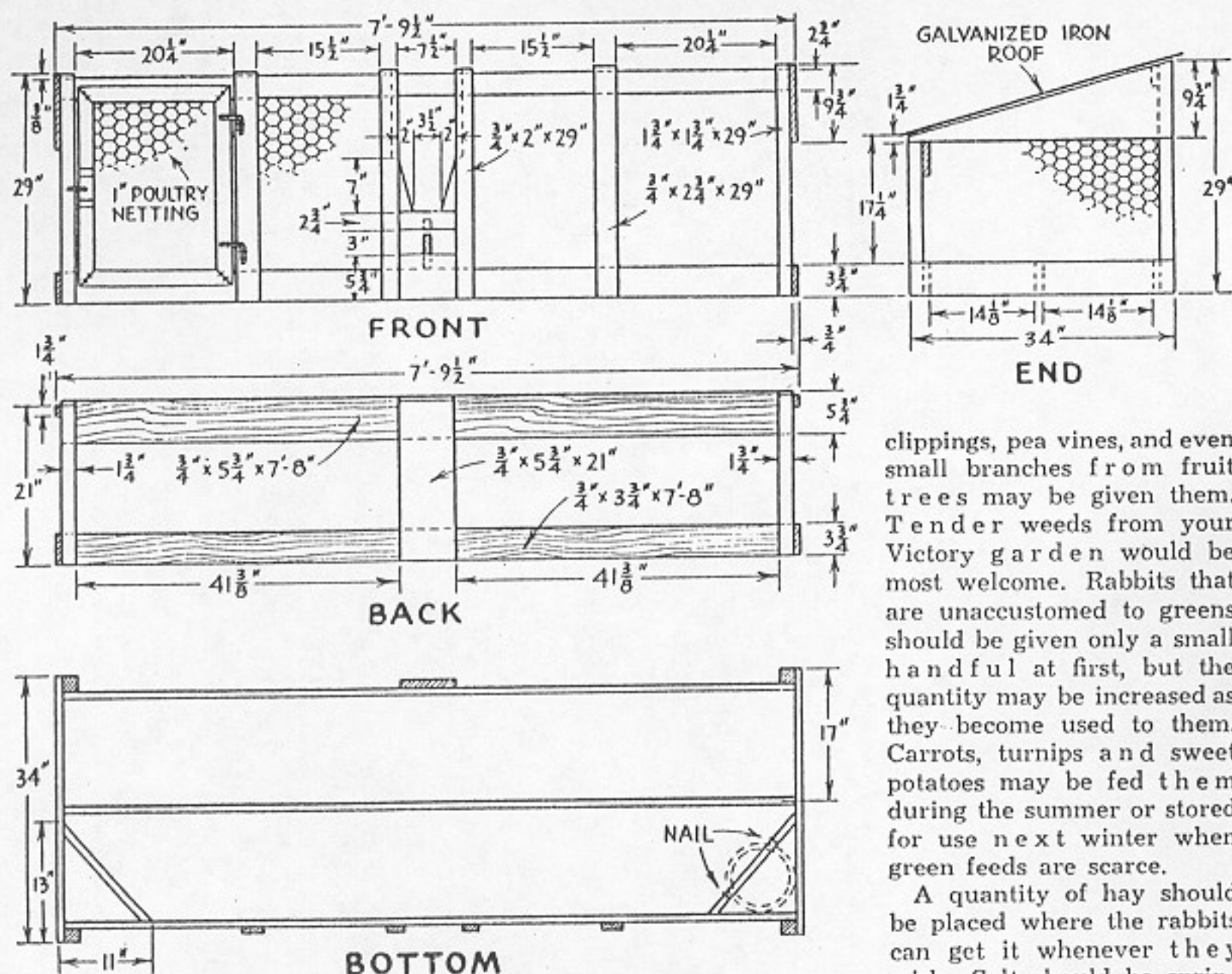
You might begin your venture with a doe mated at a reliable dealer's rabbitry. If you have plenty of space, three or four does and a buck will furnish you with all the rabbit meat your family will use. And it is just as easy to prepare as chicken.

Rabbits cost from \$4 to \$6 each, which might seem high until you stop to think that your family of one rabbit will have increased to 16 or more within six months.

Plenty of fresh water



Cut up a fryer rabbit in this way, and use suitable containers for display and handling if you plan to sell the meat.



This wooden frame wire hutch differs in a few minor details from the better hutch shown in the accompanying plans, but it does show the simplicity of construction and the little material required.

must be kept in the hutch. Be careful that the pan isn't too small—they consume an amazing amount of water.

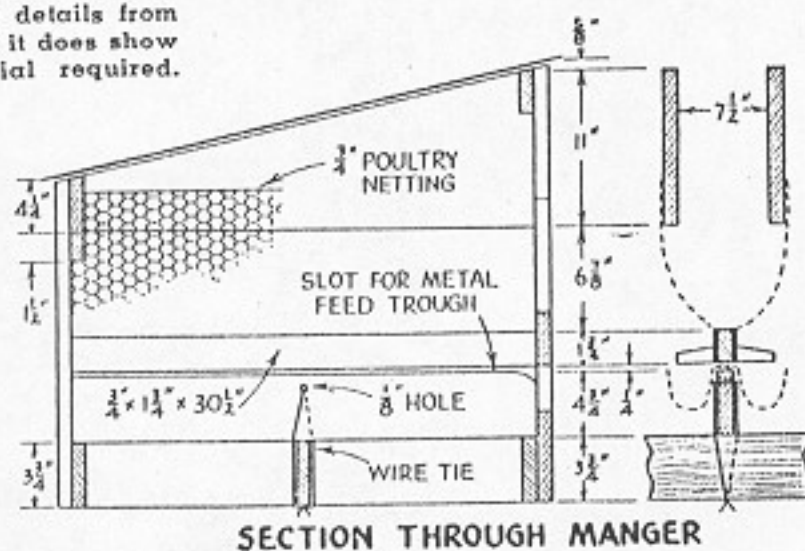
You have a pretty wide choice of what to feed your rabbits. They should be fed whole grains such as oats, wheat, barley and rye, but the kind you select would depend largely on what you have on hand, or the cost in your locality.

Dry bread and clean table waste, except meat and greasy foods, may be used to vary the food and keep costs to a minimum. Potato peels, lawn

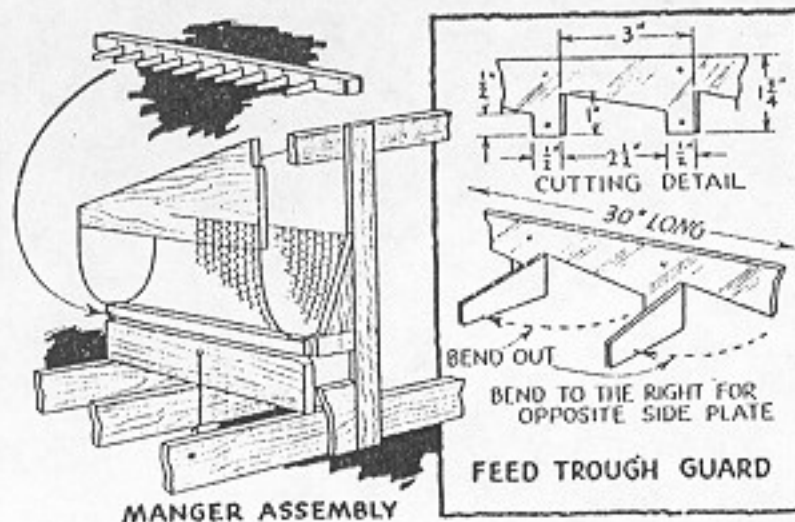
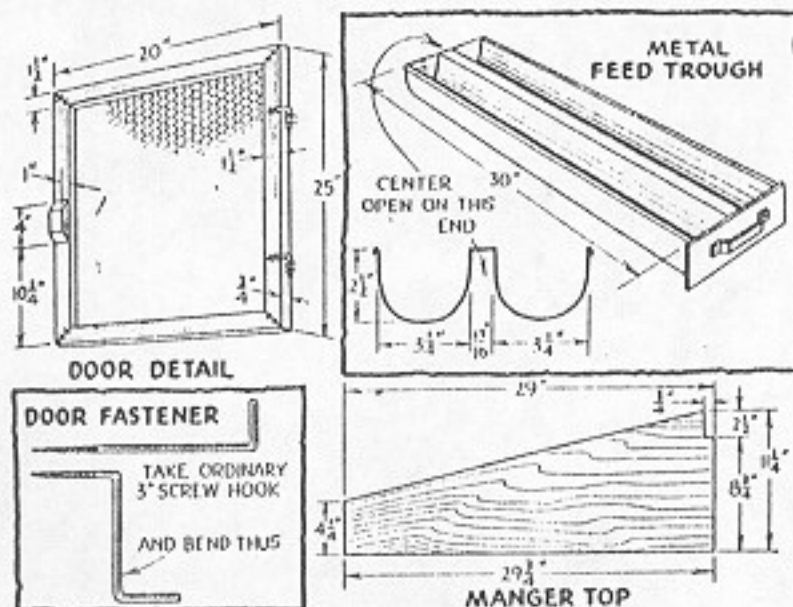
clippings, pea vines, and even small branches from fruit trees may be given them. Tender weeds from your Victory garden would be most welcome. Rabbits that are unaccustomed to greens should be given only a small handful at first, but the quantity may be increased as they become used to them. Carrots, turnips and sweet potatoes may be fed them during the summer or stored for use next winter when green feeds are scarce.

A quantity of hay should be placed where the rabbits can get it whenever they wish. Salt should be sprinkled on the food every week or so, or a small block of salt should be nailed up in the hutch where the rabbits may get at it conveniently. Rabbits, like cows, don't receive enough salt from the feed we humans provide for them to keep healthy.

How often you feed your rabbits each day is largely a matter of personal preference, but once having decided on a schedule, you should stick to it. A doe and



her litter should receive all they will eat; but the other rabbits are inclined to overstuff. Two handfuls of oats per day is a good average quantity to feed. You might experiment with how much grain, or grain and household scraps, they will eat within a half hour, and this will be about the right amount. The right feeding schedule will pay for the effort many times over.



Mating and Nesting

It is customary to mate the doe as soon as the litter is weaned. In this manner it is possible to produce four litters a year. A litter of seven or eight is considered the best size. When there are more, the weaker ones should be destroyed.

A box with straw to be used in making a nest should be placed in the hutch 27 days after mating. The doe will line the nest with fur from her own body to make a cozy place for her young. Like most pets, they are born naked and blind, but begin to grow hair after two weeks. It is best to leave them with their mother until they are eight weeks old, and within another month they will be ready for frying.

When you start to lift a rabbit, you will be surprised to find that they sometimes weigh as much as 16 or 18 pounds. Never lift them by their ears or legs. To lift them without injury, you should grasp the fold of skin over the shoulders with your right hand, keeping the back of the animal toward your body. Place your left hand under the rump to support the rabbit's weight.

Hutch Construction

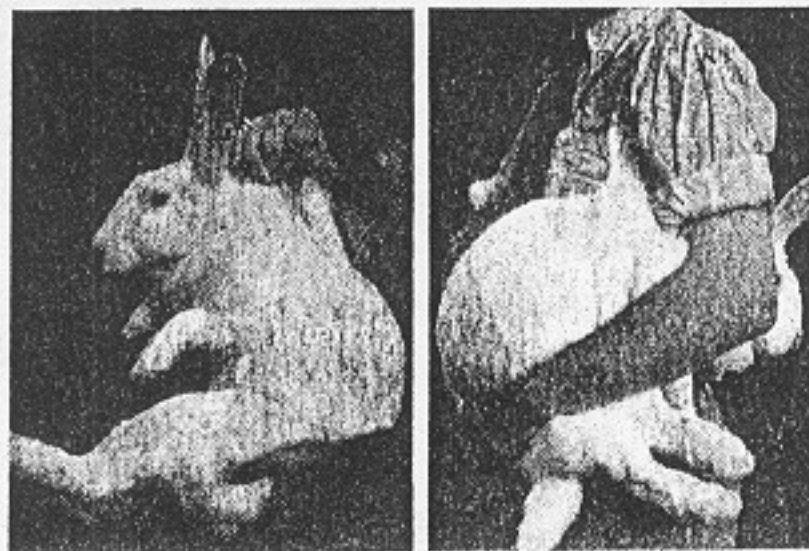
In mild climates little protection is required, other than a good roof. The sides of the hutch's may be wholly or in part of wire netting. The standard hutch is four feet long, two and a half feet wide and two feet high.

The hutch can be constructed of scrap lumber, used chicken wire, and old crates. If it is to be left in the open, the roof should be covered with tarpaper which overhangs the wire below. For convenience, a wooden frame should be made for the wire door in front.

The hay can be kept in a Y-shaped manger made by nailing a few slats between one side and the roof. An empty tin for water should be nailed to another side. Very professional looking containers for the food can be made out of a five-gallon oil can if you have one handy. The hutch should be placed where it is protected from

LIST OF MATERIALS
LUMBER

Parts	Pieces	Sizes
Front corner posts.....	2	1 3/4" x 1 3/4" x 29"
(If legs are desired, the pieces should be 60" long for a single deck unit and 76" long for a double deck unit.)		
Door jambs	2	3/4" x 2 3/4" x 29"
Manger front	2	3/4" x 2" x 29"
Triangular manger front.....	2	3/4" x 0" x 2" x 7"
Manger front	1	3/4" x 5 3/4" x 7 1/2"
Manger front	1	3/4" x 2 3/4" x 7 1/2"
Rear corner posts.....	2	1 3/4" x 1 3/4" x 21"
(If legs are desired, the pieces should be 52" long for a single deck unit and 68" long for a double deck unit.)		
Manger rear	1	3/4" x 5 3/4" x 21"
Top front	1	3/4" x 2 3/4" x 7'8"
Top rear	1	3/4" x 5 3/4" x 7'8"
Bottom	3	3/4" x 3 3/4" x 7'8"
Top ends	2	3/4" x 1 3/4" x 9 3/4" x 34"
Bottom ends	2	3/4" x 3 3/4" x 34"
Crock supports	2	3/4" x 2 3/4" x 17"
Manger top	2	3/4" x 4 1/4" x 11 1/4" x 29 3/4"
Manger bottom	1	3/4" x 1 3/4" x 30 1/2"
Feed-trough rack	1	3/4" x 4 3/4" x 30 1/2"
Vertical doors	4	3/4" x 1 1/2" x 25"
Horizontal doors	4	3/4" x 1 1/2" x 20"
Door-latch blocks	2	1" x 1 1/2" x 4"
GALVANIZED IRON		
Feed-trough guards	2	1 3/4" x 30" (24 gage)
Roof	1	36" x 8' (26 gage)
MISCELLANEOUS		
Floor	1	30" x 8'
(Use 3/8" mesh 17 gage galvanized hardware cloth)		
Manger	1	24" x 36"
(Use 3/4" mesh, 16 gage poultry netting)		
Front and doors.....	1	24" x 8'
(Use 1" mesh, 18 gage, poultry netting)		
Back and ends.....	1	18" x 14'
(Use 1" mesh, 18 gage, poultry netting)		
Hinges	4	Door latches—2
Four-penny box nails, for front, rear and roof.		
Eight-penny box nails, for posts, ends and bottoms.		
Poultry netting staples.		



Lift a medium weight rabbit as shown at the left. At the right is the correct way to lift and carry a heavy rabbit.

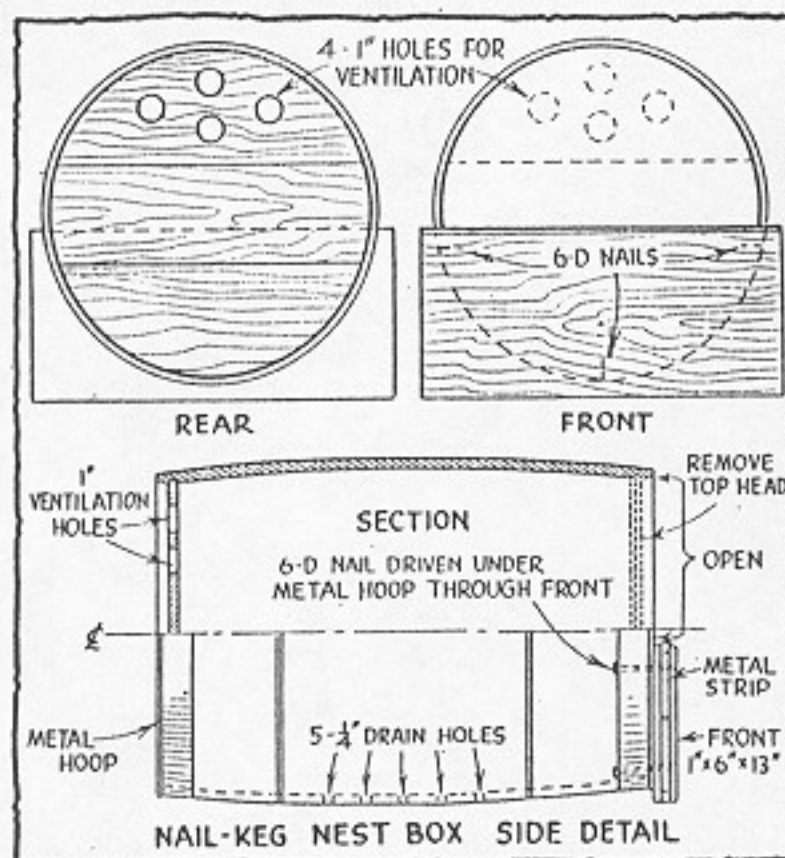
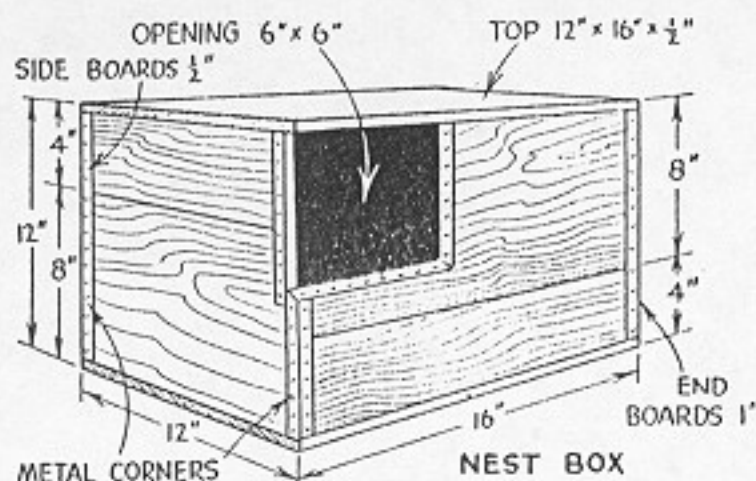
the wind and storm, such as by the side of the house or garage or barn or other building.

Clean Hutches

The hutch should be kept clean. If the floor is solid, a scraper can be made by nailing a flat piece of tin to a wooden stick. With this hay, which has fallen on the floor, unused feed and droppings may be easily removed. Floors, which will be less trouble to clean, can be made by placing inch slats a half inch apart. These spaces let the soiled hay and other refuse drop through. Trays should be placed underneath and cleaned periodically.

Nest containers should be large enough to prevent crowding but small enough to keep the occupants warm by their own body heat. Two general kinds are used extensively—the box type and the nail-keg type.

The box type nest is constructed so the top and bottom can be removed to facilitate cleaning. The nail-keg nest is inexpensive and easy to construct. A nail keg with metal end hoops is best for the purpose. One with a head diam-

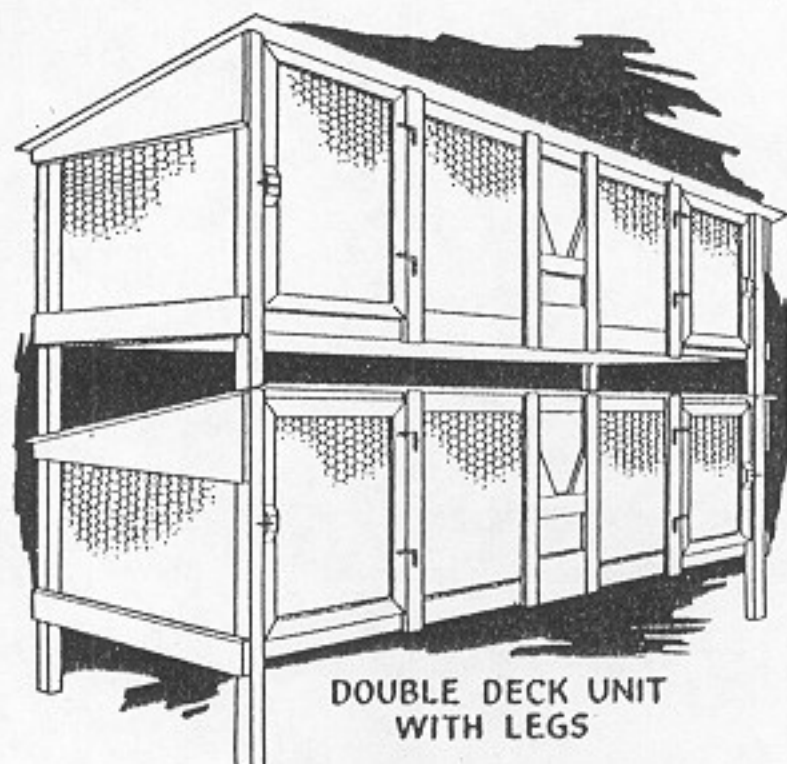


eter of 13 inches is preferable for does weighing more than 12 pounds; a diameter of 11½ inches for those weighing 8 to 12 pounds; and a diameter of 10 inches for those weighing less than 8 pounds.

Proper feeding and cleanliness are the most important precautions to take against disease. If you keep the hutch clean, and change the water and feed regularly, the chances are that you will not be bothered by sickness in your rabbitry, something much to be avoided.

They Are Not Pets

One final word of warning. Don't treat your rabbits too much as pets. They are very interesting creatures, and children are likely to become particularly fond of the white ones. But if you are planning to use them to supplement your meat supply, you don't want to become too attached to them. It might be a good idea to buy a white rabbit for the children to center their affections on, and a breeding stock of colored ones, for straight-out eating purposes.





MONEY MAKING OPPORTUNITIES

SCIENCE AND MECHANICS OCTOBER, 1940 ALFRED HAMILTON, Editor



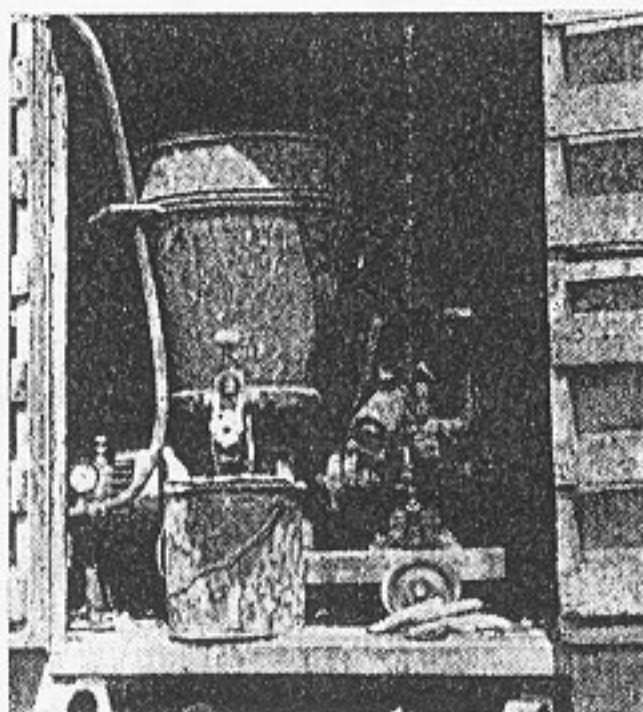
E. C. Holford believes a man has a right to smile when he builds his own business and makes it pay.

UNEMPLOYMENT and a sense of insecurity were for too long a time the lot of E. C. Holford of Grandville, Michigan.

During idle days his mind turned many times to the garage man, the grocer, and other local men each of whom owned a business of his own. No matter how modest his business, each seemed to enjoy a sense of security.

To achieve this same feeling of independence became Mr. Holford's ambition. His search necessarily limited him to something that would require only a small cash outlay, a business not overcrowded, and one not requiring much spe-

Dollars in Refinishing Old Masonry



An auto trailer carries the machine that mixes the material and furnishes the air pressure for the spraying application. It is easy to move quickly from one job to another.



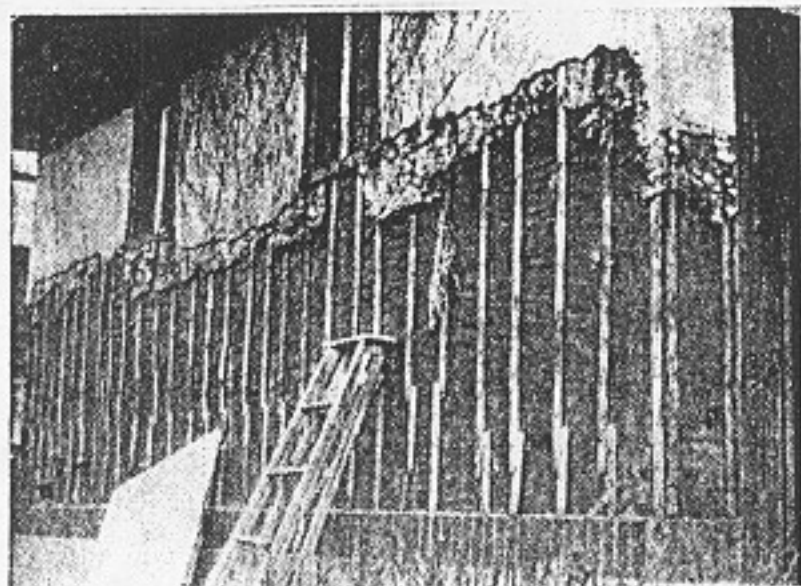
Almost any thickness of material desired may be sprayed on from the mortar-like mass in the container held by Mr. Holford. The material is easy to apply.

cialized knowledge. With these reservations, his search took him through many possible fields of endeavor. The building industry appealed to him as having the best potential stability and future growth, and in the building industry Mr. Holford found the opportunity to become his own boss.

Many Prospects for Orders

His choice was a kind of work that up to the past few years has been seriously neglected—that is, the surfacing of old and new masonry construction. One need only to look around in any community to see a vast amount of potential business that can be got by explaining to the owners that there is an economical way to beautify and protect masonry surfaces, such as those on old stucco, brick and concrete buildings, also, the interiors of many commercial and industrial buildings. Every home owner, too, is a prospect for a colorful, permanent surface on his basement walls, converting the present drab, unpleasant basement rooms into cheerful playrooms, useful laundry rooms, home workshop, etc.

Mr. Holford learned through an advertisement that a manufacturer was offering a process consisting of a specially prepared waterproofed material (called "Colorcrete") in



Severely deteriorated stucco must be removed before the re-surfacing material may be sprayed on.

thirty colors and shades, and a pneumatic machine for the application of this material. The simplicity and ease of operation as well as the abundance of informative sales literature that the manufacturer furnished his operators gave Holford the courage to start work in a field that was new to him.

Low Cost of Doing Business

Today he is the owner of a substantial business of his own. He is his own sales manager, his own foreman and workman. He takes the orders and does his own work, with the exception of hiring a helper for some jobs where it may be more convenient to work with two men. He needs no shop or store. He has no rent to pay, and no overhead eats up his earnings. An ordinary automobile trailer carries all his equipment consisting of the mixing machine, some ordinary garden hose and whatever quantity of material he may need for the job in hand.

Regarding the actual money return on this kind of work, Mr. Holford has this to say:

"I have just finished the job in Wyoming Park. We have kept a careful record of our cost figures and the final analysis of these figures is as follows:

2,000 sq. ft. net area. 15 bags material used.	
Selling price to customer.....	\$200.00
Material cost	\$45.00
Labor—2 men @ 50c per hr.	
for three days	22.00
Repair work before surfac-	
ing—40 hrs. @ 50c.....	20.00
Job cost me	87.00

My net earnings on job.....\$113.00

"This house was originally finished with a pebble dash stucco several years ago and when I was called on the job I found it to be badly deteriorated. In fact, some of the old stucco was cracked up and some of it was breaking away from the lath. This accounts for the repair work which was necessary before we could apply the material and which is covered by the forty hours of labor shown in the above figures.



And here is the completed job—the spraying of an entire house—which netted Mr. Holford \$113.00.

"My net earnings of \$113.00 pleased me very much, you may be sure."

One Job Sells Another

The growth of Mr. Holford's business has been very rapid and mostly through other people approaching him while he has one job in progress. He writes:

"Naturally, I was pleased, especially when I found that the first jobs were selling others. You would be surprised if you knew what a lot of interest is created when I start my machine. People ask questions about it, want to know what the material is and cost to re-surface their houses. I have done only a little advertising this year and have not employed any salesmen because the work I have done has brought me all the new business I could handle."

Raising Quail For Profit



Snapped on a "bob-white" farm.

NEARLY everybody at some time or other has heard the cheery, vibrant call of "Bob-white," but probably not one person in a hundred has dreamed that quail raising for profit would become a fascinating hobby or even a full-time occupation.

Yet that is just what has happened, is happening now. At the present price of farm products, one pair of pen-raised quail is worth as much as ten bushels of wheat, or twelve bushels of corn, or five barrels of potatoes. Pen-raised quail are worth \$3.00 each, for propagation purposes, and there is a steady sale for them at that price. One setting alone can produce \$30.00 in sales.

Quail raising under modern methods is comparatively simple. The average farm boy or girl can raise a pen of quail just as easily as a flock of chickens and make even more money on it. This does not mean that quail raising is an easy, quick way to get rich. Far from it. But it is a safe way to add a substantial sum to income.

Nineteen Quail from Twenty-Two Eggs

Take, for illustration, Bob Phillips, a factory worker living on a farm near his work, at Baldwin, N. Y. He hatched and raised nineteen quail out of twenty-two eggs, and this was his first attempt. Getting nineteen quail out of twenty-two eggs is not only out of the ordinary, it is exceptional! But suppose that Bob had raised only ten birds. He would still have made a profit of \$24.50 in his venture, as the total cash outlay in raising them was only \$5.50.

Bob told us—"I located two quail nests on the farm just before mowing time. I knew the nests would be destroyed if something wasn't done about it, and I decided to see what I could do to hatch and raise those quail.

"After making a few inquiries, I managed to get a pamphlet on quail breeding from The Game Conservation Society of New York. This pamphlet gave information both as to the artificial and the bantam method of propagation. I decided on the bantam, as I had had a little experience with chickens.

Put Bantam Hen to Work

"Fortunately, I was able to obtain two bantam hens that were setting. I made my hatching boxes according to the instructions in the pamphlet and placed the hens on the eggs. For twenty-two days I watched and awaited anx-

iously the outcome. On the twenty-second day, the eggs began to pip. On the morning of the next day there were twenty-one baby quail in the nests.

"By following closely the instructions I have raised nineteen of those birds to maturity. As I had an old hen coop about the place and boards necessary to build my rearing pen, my total cash outlay, including the cost of bantams and feed, amounted to \$5.50. I had lots of fun raising the quail."

At the present writing, Bob's quail have a market value, for propagation purposes, of \$57.00, or a net profit of \$51.50.

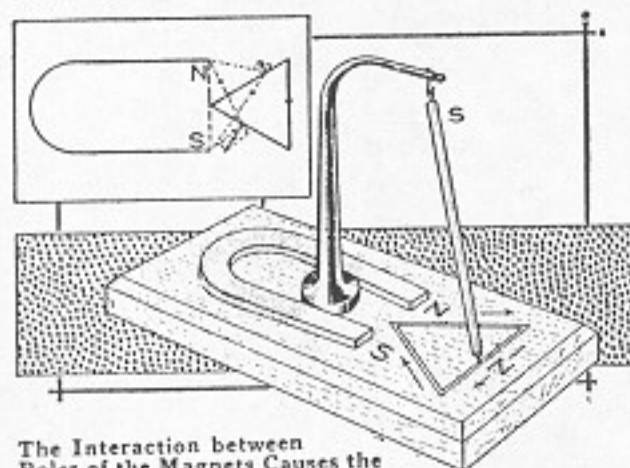
What Bob Phillips has done, the average farm boy or girl can do. Even though their percentage of hatch or raising the birds to maturity may not be as great as was Bob's, they can make a handsome profit by raising quail.

There need be no fear that, by the time your quail are ready for market, there will be a surplus and the price will be down. It is safe to say that for several years, at least, the price of pen-reared quail will be in the neighborhood of \$3.00 each. It isn't solely the dollars and cents value that should interest the farmer in quail. Quail on the farm are worth more than the time and trouble it takes to raise them, if only to destroy harmful insects. Too, quail propagation must be resorted to if the sport is to continue.

A Perpetual-Motion Puzzle

Popular Mechanics — 1919

The fallacy of perpetual motion is now so generally understood that the description of a new scheme for attain-



The Interaction between Poles of the Magnets Causes the Traveler to Move around the Triangle

ing it is only justified in so far as it may be instructive. The sketch illustrates such a device, apparently successful, and the discovery of the error in it is both instructive and interesting.

Mount a horseshoe magnet on a wooden base, and into the latter cut a continuous groove along the three sides of a triangle opposite the poles of the magnet, N and S. Suspend a long, narrow bar magnet on a universal joint from a standard. A pin projects into the groove from the lower end, which

is its north pole, and can move only along the triangular course.

Start the device with the suspended magnet in the position shown. The lower end will tend to move in the direction of the arrows, because in so doing it is getting farther away from the repelling north pole of the horseshoe magnet and nearer the attracting south pole, which action will bring it to the corner of the triangle in the foreground. It will next move down the side as indicated by the arrow, because along that line it is nearer the attracting south than the repelling north pole. When it reaches the end of its trip, at the angle between the poles of the magnet, the attraction and repulsion will be balanced, but a slight jar will carry the traveler beyond the angle.

The third leg of the triangle will be covered similarly, the north pole repelling the traveler. On this basis the motion should continue indefinitely, but a test will show that it will not do so.

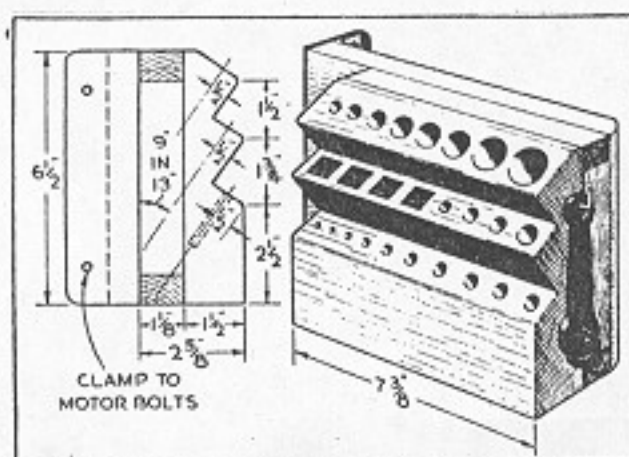
The corners of the triangle should be rounded slightly and it would be better to use several hanging magnets, flexibly connected, so that when one is at the dead center the others will carry the traveler on.

Rack for Drill-Press Bits Forms a Good Practice Project

Popular Science, 1943

IF YOU'RE learning to use a new drill press, what could be more appropriate than making this rack? It is easily attached to the motor bolts on the drill-press head, and will hold several woodworking bits, mortising chisels, and twist drills of the most frequently used sizes.

On the circular saw, rip out the stepped face block at the angle shown. Tilt the table of the drill press to the same angle by using a T-bevel, and clamp on a fence to hold the work against. Drill each hole with the bit it is to fit. Build up the body as shown so that it will not warp, and attach a metal mounting bracket.—



THREE SIMPLE STILLS - *Sma Brothers*

The ability to distill your own food flavorings, perfumes, and herbal concentrates may not be considered very survival oriented. But the same process can be used to distill impure water and to make medicines. Not to mention the more commonly associated skill of moonshining.

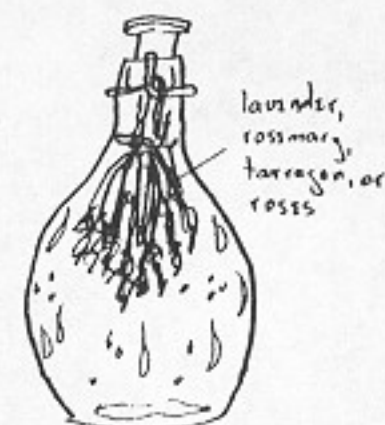
The moonshine still is more complicated than I will address here. For now, I will concentrate on stills which can be used for survival. It's amazing how ingenious a still can be when you are desperate. I once made a still out of a hollow rock and a piece of black plastic just to get some fresh water.

1. The first still is the simplest of all stills, used for extracting floral essences. Find a clear, narrow necked, large jar. Clean it well, and dry it completely out. Fit as large a bundle of lavender, roses, or other flowers with a large amount of oils through the neck of the jar as you can - without letting the flowers fall all the way in. Cap the jar. You can use cork, or Saran Wrap, or a piece of paper tied on. Set the jar in direct sunlight. Leave it all day. That evening, you will have all the oils the flowers can give. Remove the flowers, and pour off the oil. Wash the jar again, and repeat as often as you want.

2. The second still is more complicated, but still simple enough for even a young child to make. My children made their first one out of a cardboard box, some black paint, and a piece of broken window glass. A more permanent one can be made out of wood. You will need three pieces of $\frac{1}{2}$ " board - one 11"x9", one 11"x19", and one 9 $\frac{1}{4}$ "x19". Cut the 9 $\frac{1}{4}$ "x19" board diagonally. You will also need a piece of clear glass 11"x21", an old metal ice cube tray (the kind that had the removeable insides), flat black paint, nails, and some scrap wood to make the legs. Nail the 11"x9" board to the 11"x19" board at right angles. Nail the 9 $\frac{1}{4}$ "x19" triangle pieces on the ends. Paint the inside flat black. The legs are optional - you can use a brick for the back support. The still is now ready to set up and use. Place the still on the ice cube tray and a brick where the sun will shine into the box most of the day. Set inside the box a bowl of fresh herbs or flowers with a little water (to distill water, set only water in the bowl). Rest the glass across the front of the box with the bottom edge on the ice cube tray. The distillate will run down the glass and collect in the ice cube tray. When $\frac{1}{4}$ of the liquid in the bowl has collected in the ice cube tray - you have purest water or highest concentrate of distillate. Discard what is left in the bowl and start over.*

3. The third still is the most complicated in this article. It requires a heat source and a water source to use. You will need: An enameled saucepan, a stainless steel funnel with the largest part of the funnel the same diameter as the saucepan (you want it to be a tight fit), 10 feet of copper plumbing tubing the same diameter as the smallest part of the funnel, a #10 can, and the equipment to weld the tubing to the funnel, cut a hole in the bottom of the #10 can, and weld the tubing through that hole. You will also need some sand to bend the tubing without kinking it.

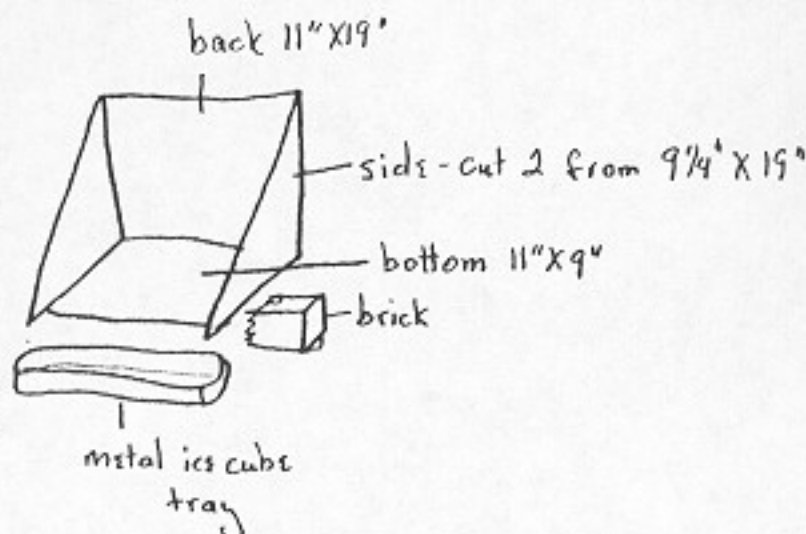
To assemble the still: First weld the tubing to the funnel. Fill the tubing with sand and bend it according to the illustration. Cut one hole in the #10 can just large enough for the tubing to fit through. Set the saucepan on the heat source you plan to use most, put the funnel lid on it. Now adjust the tubing in the #10 can so it comes out to drip into your peeper (collection bottle). When you have the tubing where you want it, weld it in place. Be sure it cannot leak around the weld. Cut a small second hole in the opposite side of the tubing hole in the bottom of the can. With a water source, your still is now ready to use. Rinse and clean it well to remove the flux and sand. Measure the amount of water you put in the saucepan because you want to stop the process when you have collected 1/4 to 1/3 of the distillate. Add herbs or flowers to the water if you want. Turn on the heat and bring the water to a boil, then lower the heat to a heavy simmer. While the water is heating, pack the can with ice, and fill with water. You can plug the second hole, or let it drain as you distill. If you let it drain as you go, keep filling it with ice and water. This condenses the steam, which is your distillate. Be sure to place a collecting bottle at the end of the tube! When you are done, drain the can and clean the tubing and the saucepan well - particularly after roses! I once distilled some roses, then (showing off with some friends) distilled a can of Miller Lite. The distilled beer (which will be flat, because you distill out the carbonation which gives beer its head) tasted strongly of roses.



1. Simple Bottle Still

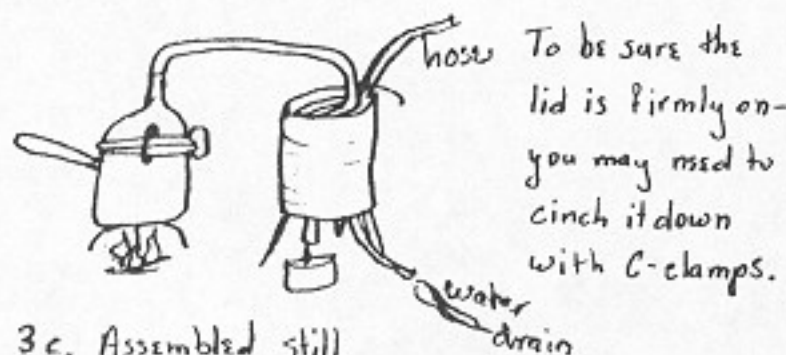
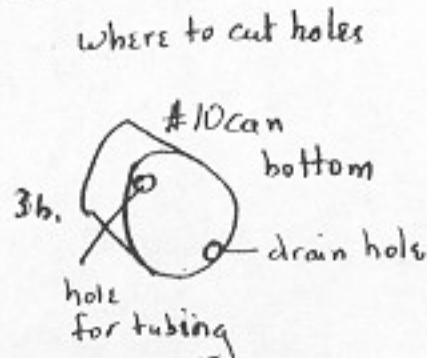
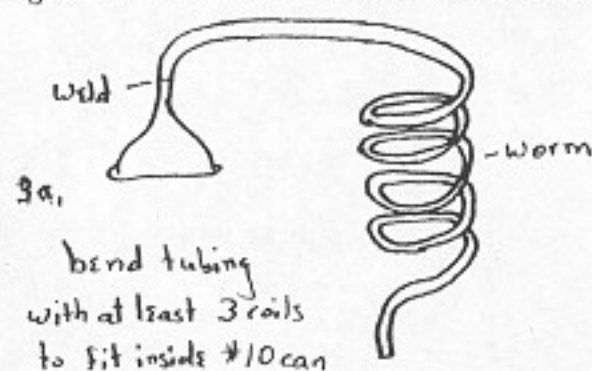


2a, cut away side view of Solar Still



2b,

metal ice cube tray



You may have to support the #10 can with a stand.

To be sure the lid is firmly on - you may need to cinch it down with C-clamps.

FEDERAL JUDGE H. FRANKLIN WATERS**CORRUPT SERVANT OF A CORRUPT SYSTEM****by Kurt Saxon (Plaintiff)**

In the Middle Ages, if a peasant had been so bold as to sue a noble, the outcome was obvious. Today, our Constitution guarantees the right of any citizen to get a fair hearing in a trial, regardless of the status of the defendant. Yet, the medieval system can still be imposed on a plaintiff if that plaintiff is without means, and especially if the plaintiff is in disrepute and can be seen as a political offender.

H. Franklin Waters, United States District Judge, Arkansas, accepted a case wherein Plaintiff was suing Lawrence Harper, vice president of The Democrat-Lithograph Printing Company (DP&L) and Bill Blann, owner of Delta Press. The causes of action were breach of contract; fraud; breach of fiduciary duty and copyright infringement.

Judge Waters is a good servant of "the system." He undoubtedly had personal knowledge of Plaintiff as a notorious public figure in Arkansas. So he automatically denied all Plaintiff's evidence against the defendants and arbitrarily gave the decision to the largest printing firm in the state, and Bill Blann, a common crook and swindler.

Judge Waters would not have minded acting as attorney for the corrupt DP&L, with their \$20,000,000 in assets, prestige, and political influence. But he may have had misgivings about favoring Blann. Even so, Blann had to be cleared if DP&L was to be exonerated.

Defending the system against such people as Plaintiff was his perceived duty. Every judge with a totalitarian mind set sees the political offender as a far greater threat to the system he serves than the simply crooked. So although Blann is an obvious

crook, he must be favored over the political offender, who must not be allowed to prevail.

What led up to the trial was financial reverses suffered by Plaintiff which made him vulnerable to a hostile takeover by Blann.

Plaintiff was out of his best selling book, The Poor Man's James Bond and lacked funds for printing. Blann offered to pay \$15,000 if Plaintiff would repay the loan in 90 days, along with \$3,000 interest.

Failure to pay the full amount would result in Plaintiff's signing over the commercial rights to The PMJB.

As security against Plaintiff's failure to sign over the rights, 3,000 PMJB's were held by DP&L to be turned over to Blann if Plaintiff did not sign. The trial showed that DP&L had actually turned over the 3,000 books to Blann even before the due date.

When making the agreement, Plaintiff was sure that his biggest dealers, who had routinely paid up to \$10,000 yearly for his books would pay off the debt. Plaintiff duly offered the books at \$6.50 each, \$2.00 off the wholesale price if up to 1,000 where bought at one time.

Although the books were certain to sell, the dealers showed no interest. It was later learned that Blann had approached all the dealers he anticipated would make such a purchase and urged them to boycott Plaintiff, causing him to default. His offer was of perpetually lower prices regardless of the amount of books purchased.

That they complied is shown by Blann's invoices to his dealers, reflecting the uneven pricing for PMJBs between small dealers and the larger ones, as shown below:

Guardian, Doug Blann (Blann's own brother), Jim's Military Relics, Tino International, CRB Research, DWARF, AARC0, Anvil, Enoksen and The Larder; \$9.80 each.

Paladin Press, Federal Sporting, Butokukai, Loompanics; \$7.00 to \$7.50 each. Conant's Landing; under \$6.00.

While the larger dealers were waiting for the rights to PMJB to revert to Blann, they bought what books they needed to fill current orders but did not take advantage of Plaintiff's offer, effectively boycotting him. Judge Waters ruled that the unhelpful amount of books purchased showed there was no boycott.

Although Plaintiff might have gotten credit from DP&L, Blann assured him that DP&L did not give credit. The agreement was for a loan. However, the trial showed the printing was done on credit. Blann did not have to come up with any money and so did not risk anything. Blann had told Plaintiff he had borrowed the money to pay for the printing.

Had Plaintiff known the work was to be done on credit, the agreement would have been entirely different.

When he defaulted, having suspicions but no proof, Plaintiff signed over the rights to PMJB. He then requested the return of the books held as security; books with a retail value of \$47,460. Blann would not give them up.

Note: PMJB had earned hundreds of thousands since 1972 and was still a consistent best-seller. It was worth several times the amount of the loan and the books were legally Plaintiff's. But Judge Waters ruled that since the agreement didn't specify the return of the books, they belonged to Blann.

One doesn't need to go to law books for this. Anyone sitting behind a desk at a bank would affirm that once a debt is paid, any security against payment is automatically returned to the debtor.

Following Blann's fraudulent acquisition of the rights to PMJB 1, Plaintiff revised and re-copyrighted PMJB 1, renaming it "The New Improved" PMJB. This was his only defense against Blann's acts and was indeed an attempt to make the stolen property worthless. Judge Waters, true to form, accused the Plaintiff of acting with "unclean hands" and ruled the new copyright invalid (Exhibit B-26).

Meanwhile, Plaintiff had struck up a pleasant association with Harper by phone after having printed and paid for several thousand brochures. To Plaintiff's amazement and delight, Harper offered him credit for the printing of 5,000 each of six books, including The New Improved PMJB. That was a total credit of \$98,000 for 30,000 books!

The books were printed and during a phone conversation with Harper, Plaintiff said he was not going to sell Blann any more books. Without hesitation, Harper then said, "Billy says all your books are in his catalog and if you won't sell him any more he won't pay me the \$80,000 he owes me for 135,000 catalogs."

This shows that Blann had anticipated Plaintiff's refusal to do further business with him and so he had threatened Harper.

Plaintiff, out of gratitude to Harper for the credit, told him he could transfer 1,000 books of any selection to Blann and Blann was to send Harper \$7,500 to be applied to Plaintiff's account with DP&L. The 1,000 books would help with Blann's present customer orders, after which, Blann's later catalogs would not feature Plaintiff's books.

In the following weeks, Plaintiff noticed many full page ads in weapons-oriented publications featuring his books. The ads were by other dealers than Blann and the books advertised had not been ordered from Plaintiff. The books were also in the catalogs of other dealers who had not bought them from Plaintiff. All the full-page ads in national magazines and large

circulation catalogs had to represent a guaranteed source of many thousands of books.

Plaintiff then told Harper that Blann was marketing thousands of books through other dealers. Having utmost faith in Harper's integrity, Plaintiff naively asked him if someone else at DP&L could be transferring the stored books to Blann. Harper said that was impossible and suggested Blann might be getting the books printed somewhere else.

Plaintiff had promised Harper large and prompt payments to pay off the debt. But with Blann and his dealers saturating the market with Plaintiff's books, Plaintiff was increasingly unable to live up to his promise.

In short, with most of Plaintiff's former dealers buying Plaintiff's books from Blann because of Blann's undercutting Plaintiff's prices, nearly everyone interested in the material was getting it through Blann and Plaintiff was being forced out of business.

Meanwhile, Harper was becoming impatient and was demanding payment. Finally after Plaintiff's many complaints about Blann, Harper said that if he believed Blann was stealing his books, Plaintiff ought to sue Blann.

Plaintiff could not believe; did not want to believe, that his benefactor had betrayed his trust. Even after he had gone to an attorney, Plaintiff resisted an outright accusation of Harper. Nonetheless, Plaintiff could see no way for Blann to act without Harper's compliance. Plaintiff had to confront Harper with the accusation in order to get at the truth.

The Little Rock attorney, Steven Carver, contacted Harper and verified that Harper had, indeed, been secretly selling Plaintiff's books to Blann from the outset. In compliance with Harper, Carver drew up an agreement that if Plaintiff should drop the suit Harper and DP&L would sell no more of Plaintiff's books to Blann. Plaintiff refused to sign.

Plaintiff had lost too much by Harper's crookedness. Besides, he knew that neither Harper nor DP&L could be trusted, as subsequent events have proven. Had Harper admitted his guilt early on and cut Blann off from access to Plaintiff's books, Plaintiff would simply have sold the books, paid off Harper and taken his business elsewhere. But Plaintiff had been hurt too much, both financially and emotionally, by Harper's callous betrayal. Especially since he realized that Harper's generous credit was not on his behalf, but on Blann's.

Exhibit A proves that Harper printed 30,000 books for Plaintiff. Exhibits A-6, 7 and 8 show that out of those 30,000 books, Plaintiff was shipped only 11,836. Blann got 18,164. Less the authorized 1,000, that left 17,164 with a retail value of \$291,788. It doesn't matter what Blann got for them, since he wasn't supposed to have them. Had Blann not been sold the books by Harper, Plaintiff could have sold them to those who bought them from Blann and thus satisfied his obligation to Harper.

Blann wanted those books to sell. Owing Harper \$80,000 at the outset and threatening not to pay, was enough leverage to maneuver Harper into the position of a willing tool.

So Harper printed 30,000 books on credit, further trapping himself into such an indebtedness to his company that he had to proceed, regardless of the consequences.

So the case came to court on October 2, 1990. Neither Harper nor Blann had any defense, but needed none. Plaintiff was on trial and was judged and found guilty before it began.

There was no jury. Plaintiff's attorney, a California corporate lawyer, had reasoned that a judge would give a larger award than would a jury. The idea that his client was considered by the court as unworthy of justice never occurred to him. In effect, Judge Waters acted as attorney for the defense.

In his Memorandum Opinion Judge

Waters starts off with, "This is an action for copyright infringement." In actuality, the copyright issue was incidental. The main issues were breach of contract, fraud, conspiracy, and breach of fiduciary duty.

But Judge Waters placed the emphasis on copyrights in order to exonerate DP&L. The idea being, if the copyrights were invalid, DP&L and Harper did no wrong in selling the books to Blann. But this is not so. Had the merchandise been baseball caps or bookends, unprotected, it would still have been breach of contract, fraud, and conspiracy and breach of fiduciary duty.

Even so, the copyrights were all valid. Of Survivors 1 and 2 Judge Waters wrote (Exhibit B- 19), "The evidence before the court indicates that Survivor 1 and Survivor 2 were publicly distributed in 1984, more than one year before the date of the first publication. Thus, the copyright protection on these works has been forfeited."

The allusion to 1984 indicates an August 1984 ad in American Survival Guide (Exhibit B-41) featuring Survivors 1 and 2, Poor Man's James Bond, Granddad's Wonderful Book of Chemistry and others. The same ruling would have invalidated the last two, but did not.

The books distributed in 1984, and before and after were duly copyrighted earlier editions. In the 1987 edition of Survivor 1, the first page (not the title page) says "Copyright 1976 by Kurt Saxon." In the 1988 edition of Survivor 2, the first page (not the title page) says "Copyright 1977 by Kurt Saxon."

The books in the ad were 11 1/2 x 14, on newsprint and, except for a 1930 home workshop manual added as filler, were identical to the original 24 issues copyrighted separately and bound in their original tabloid format.

The Survivors 1 and 2 of 1987 and 1988 are 8 1/2 x 11, on glazed paper, each with 1 1/2 times more material. They were registered as compilations. The "Date-of first publication

of this particular work" (Copyright registration form TX) was 1987 for Vol. 1 and 1988 for Vol. 2. Neither "particular work" existed in 1984.

PMJB 2 was first published in 1986. The copyright registration said it was first published in 1988. The copyright notice for the first printing of PMJB 2 was typed on the title page by Plaintiff. When Harper reset the title page for the second printing he mistakenly wrote "1988" instead of "1986." When Plaintiff filled out the copyright form he was copying from the second printing and repeated Harper's error. It was a simple clerical error, not meant to deceive so could not have invalidated the copyright. Moreover, the first printing reflected the original copyright date of "The Poor Man's Armorer" copyrighted by Kurt Saxon and distributed in 1977. (Exhibit B-42) This is not shown on the title page of the second printing but the Poor Man's Armorer's copyright date is on page 6 of PMJB 2.

Judge Waters ruled the copyright to PMJB 2 forfeited. Regardless, a judge's ignorance of the validity of a document does not invalidate the document.

Discrediting the above three copyrights was important to Judge Waters. Otherwise he might have had to acknowledge that Harper had transferred 9,282 stolen books to Blann with a retail value of \$157,794, losing the case for the defense.

Had Judge Waters been impartial and wanted to see if Plaintiff's material was protected, he had but to ask. But throughout the trial he did not once address himself to Plaintiff. Had he done so, the proof would have been presented immediately, as it was in the courtroom throughout the trial.

But none of this mattered to Judge Waters. He knew Plaintiff had authored The Poor Man's James Bond and was a Survivalist and was therefore beyond the Pale.

During the trial, Judge Waters leafed through the PMJB and commented, "I'm

very disturbed by this material, especially the part about poisoning winos." Did he feel threatened? No matter. The subject matter of Plaintiff's works was not supposed to have any bearing on the outcome of the trial.

When Blann ran out of the PMJBs he had illegally kept after the property was signed over to him, plus something like 3,414 New Improved PMJBs illegally transferred to him by Harper, he had Harper print 5,370 more. (Exhibit C-25). Harper called Plaintiff and told him he was printing a run of PMJB 1 for Blann. He asked Plaintiff if he would like a run of New Improved PMJBs since all but the first 20 odd pages were the same and costs could be cut for both parties by running both editions at the same time.

Plaintiff told Harper he didn't want him to print PMJB 1 and sent a letter of protest. (Exhibit C-17). They were printed anyway. (Exhibit C-25).

Blann purposely removed the copyright notice from that printing, jeopardizing its copyright. Blann wanted others to believe the copyright no longer belonged to Plaintiff. (Exhibit B-30).

Although Judge Waters quoted the law: "A licensee's publication without copyright does not invalidate the copyright unless publication occurred by or under the authority of the copyright holder," he still ruled the copyright invalid.

Judge Waters knew Plaintiff had protested the printing and had no control over it, and in point of fact, Plaintiff didn't even know the copyright notice had been left out until much later. Even so, Judge Waters ruled, "Saxon has failed to establish the applicability of any of the S 405 exceptions. Therefore, the copyright protection on PMJB 1 has been forfeited."

This ruling is not only completely wrong, but if allowed to stand, it threatens every copyright in existence.

An important point in the trial was Judge Waters' refusal to see the marketability

of the books Harper and Blann stole from Plaintiff. Defense maintained only the 1,000 authorized books had been marketed. Plaintiff sought to prove the 1,000 would not fill even the orders from the initial 135,000 catalogs Blann ordered from Harper.

Blann had been printing and sending out many hundreds of thousands of catalogs. He had been buying name lists representing many thousands of weapons buffs who were the best market for Plaintiff's books and sending them catalogs. Blann was also selling thousands of Plaintiff's books at gun shows, from his own tables and also to other gun show dealers in such books. He also had display ads in just about every national gun magazine.

He was also selling thousands of Plaintiff's books to Plaintiff's former dealers, who were also selling them through catalogs and display ads in national magazines.

A definite factor in the sale of the books was that Plaintiff's books had been virtually off the market for two years. Now with PMJB 1 in a new format and enlarged and with the brand new PMJB 2 and 3 plus Chemistry and the new Survivors 1 and 2, Blann had new books for the same market. Even those who had bought Plaintiff's original works wanted the new editions.

Blann had no problem selling a paltry 17,164, or an average of 2,860 of each title in the next few months.

But Harper wasn't doing that well, in giving Plaintiff so much credit, on behalf of Blann, Harper was deeply in debt to DP&L. What with Blann clearly cornering the market in books stolen from Plaintiff, Plaintiff was unable to make large enough payments to satisfy Harper. On August 3, 1988. Harper wrote Plaintiff a four page letter explaining how much he had gone into debt printing the 30,000 books and how much Plaintiff still owed.

The letter listed five books prepared for printing at \$4,000 each (PMJB 2 had been prepared previously), or \$20,000. Next was a

cost of \$5,000 for paper for each of the six books, or \$30,000. Then was the cost of \$8,000 for the printing of each book, or \$48,000, for a total of \$98,000. Harper had borrowed from his wife and son and was deeply in debt to DP&L and feared an accounting.

The letter listed a payment of \$7,500 from Blann for the 1,000 authorized books. It followed with "Total paid, \$33,500" and "Balance, \$68,396."

Soon after writing that letter, harper regretted it. Had Plaintiff come up with the balance and demanded delivery, an accounting would have had to be made of the books illegally transferred to Blann. The remainder of the books could not have been reprinted as cheaply as had been done in increments of 5,000. Too much juggling of figures would have tripped him up with DP&L.

"Oh, what a tangled web we weave when first we practice to deceive."

Moreover, Harper couldn't apply the moneys paid by Blann for the books to Plaintiff's account because Blann wasn't supposed to have them.

So in subsequent letters, Harper denied having printed 5,000 of each of the six books. Too late!

When confronted with the letter of 8-3-'88 at the Deposition, (Exhibit C-3), Harper babbled. "But these figures don't have anything to do with anything. They don't have anything to do with books that were printed. They don't have anything to do with what Kurt paid. They don't have anything to do with anything. This is what it would have cost had I printed five thousand copies of each of those books. And that was never done."

Of that most incriminating letter, Judge Waters wrote, "On August 3, 1988, Harper sent Saxon the figures on Granddad's, Survivor 1, Survivor 2, PMJB, PMJB 2 and PMJB 3. These figures indicated Saxon owed a total of \$98,000 for printing 5,000 copies of each of the six books.

"Harper testified that these figures represented the amount Saxon would have owed DP&L had 5,000 copies of each book been printed. Harper stated he had written this letter in anger. *Italics Plaintiff's.*

This was the end of Judge Waters' comment on the letter. Note: he didn't comment on the inclusion, "Total paid by Kurt- \$33,500" and "Balance \$68,396." Judge Waters makes the letter unimportant by saying, "Harper stated he had written this letter in anger."

So Judge Waters discounted the letter's contents because Harper was angry! According to Harper and Judge Waters the letter was simply a cost estimate. Then why the anger? Harper was angry because Plaintiff had only paid \$33,500 of the \$98,000 he owed. But if the letter was only an estimate, Plaintiff would not have owed \$98,000; would not have already paid \$33,500. If the letter was only an estimate and Harper was angry, Harper would have simply refused to print the books and the matter would have ended then and there.

Judge Waters willfully, wrongfully and with extreme prejudice, discounted the most important document. That document proved Harper was a liar. It proved he had indeed printed 30,000 books for Plaintiff, had delivered only 11,836 and could not account for the remaining 17,164, unless he admitted selling them secretly to Blann.

In discounting the 8-3-88 letter, Judge Waters listed several job cost sheets indicating they represented the only actual printings. Of course, these were selected by Harper as the ones benefiting his case. He naturally left out those reflecting the printings of 5,000 of each book.

Even so, and probably by oversight, Harper included the job sheet for 5,300 each of covers for Survivor 1 and Chemistry. (Exhibit A-5). The figure of 5,300 indicates a printing of at least 5,000 of each book with 300 over to account for any extra books or damaged covers.

There is a job cost sheet for 2,570 Chemistry and 5,300 covers; same job, No. 39801. There may have been a breakdown and the rest were printed later. At any rate, no printer would print 5,300 covers for only 2,570 books. The 5,300 covers shows 5,000 were scheduled.

There is no job cost sheet for Survivor 1, but a number, 38757, along with the 5,300 covers.

Strangely, there are no job cost sheets at all for PMJB 3.

Another job cost sheet shows 1,560 copies of PMJB 2, printed for Delta Press. That was certainly over the 1,000 authorized to Blann and not ordered by the Plaintiff. (Exhibit A-11)

Still another job cost sheet (Exhibit C-31) shows 2,240 copies of New Improved PMJB illegally printed for Blann. DP&L presented a bill to Blann. (Exhibit C24). At trial, both Harper and Blann testified that Plaintiff had agreed to split a 5,000 unit printing of New Improved PMJB. (Exhibit F-13). The hatred of Plaintiff for Blann would have made such an agreement impossible. There was no job cost sheet for Plaintiff, nor was there a billing for the job by DP&L. Judge Waters saw nothing wrong in this.

If the job cost sheets prove anything, they prove shorter runs were printed after the 5,000 of each book printed for Plaintiff and to accommodate Blann.

Only six invoices between Harper and Blann for Plaintiff's books were submitted. (Exhibit C- 18 to 23) . Interestingly, all payments but one were to be sent directly to Harper at his home. Aside from PMJB 1, there were 3,380 of Plaintiff's books. Judge Waters, in treating with the invoices, (B-32) wrote, "Plaintiff introduced invoices showing Harper had shipped to Delta 576 copies of Granddad's (Chemistry). At trial, Plaintiff testified that the invoices didn't exceed the number of books he authorized distribution of.

Such a subterfuge is unworthy of a

Federal Judge. Plaintiff referred to the 576 Chemistries, which were of course, under the 1,000 authorized. Judge Waters had the invoices and knew they added up to 3,380 of all titles except for PMJB 1. Even so, the 576 figure is significant in that, had Blann been limited by Harper to the authorized 1,000 he would not have ordered more that a couple of hundred Chemistries as opposed to the more popular PMJB 2 and 3.

Just as important a piece of evidence as the 8-3-88 letter and one which Judge Waters wouldn't even comment on, was an undated letter from Harper to Blann. It was written early on, when possibly only 304 books were picked up by Blann. Their unit price, however, was only \$6.00 instead of the \$7.50 each they would have cost had Harper meant to limit Blann to the authorized 1,000.

The letter (Exhibit C-27) states that the books Blann picked up numbered 304 PMJB 2 and 3. They weren't represented on the invoices so just add 304 to 3,380 above = 3,684, 2,684 over the authorized 1,000. Near the bottom, Harper wrote, "When you need some more, let me know." This proves Harper intended to sell Blann all of Plaintiff's books he wanted, regardless of Plaintiff's orders to the contrary and as backed up by the succeeding invoices. Yet, Judge Waters disregarded that letter as evidence.

In his deposition, Harper said Plaintiff owed him \$12,000. At the trial he amended it to \$9,000. Plaintiff didn't dispute this claim because he wasn't asked and felt it too ridiculous to address. In Harper's last letter to Plaintiff (Exhibit B-43) he said Plaintiff owed him \$7,500.

What makes Harper's claim foolish is that the letter (Exhibit C-27) and the invoices proved Harper transferred at least 3,684 books over the authorized 1,000. At the rate of \$7.50 Blann was to pay for the authorized 1,000. Plaintiff was legally entitled \$20,130, none of which was applied to Plaintiff's account. Judge Waters arbitrarily awarded Harper

\$9,000.

Note: At that time, Plaintiff's copyrights weren't being challenged. Harper and Blann believed they were acting illegally, as they were, but felt they could get away with it. It was straight breach of contract, fraud, conspiracy and breach of fiduciary duty.

Judge Waters had to realize they were acting with criminal intent. Since he hated everything he believed Plaintiff stood for, he should have rejected the case.

As shown, Judge Waters cared nothing for Plaintiff's evidence. But DP&L saw it as proof enough of Harper's crookedness to fire him.

Harper's father was co-founder of DP&L. Harper had worked for DP&L for 30 years. He had been vice-president for 15 years. DP&L's decision to fire him and effectively end his career and ruin his life could not have been made lightly. The evidence was solid, even though DP&L's attorney scorned it at the trial.

But DP&L did not fire Harper because he had swindled a client, as they should have done before the suit was brought to trial. Ethics dictate that DP&L should have made amends to Plaintiff. But DP&L was not concerned about a swindled client but only for the money Harper had diverted from their own accountant to his home.

Now we come to the U.S. Court of Appeals, presided over by McMillian, Circuit Judge; Bright, Senior Circuit Judge and Laken, Circuit Judge. (Exhibit D).

Neither judge studied the case but simply rubber-stamped Judge Waters' ruling. For instance, page 3 of Exhibit D says "DP&L computer records indicated that roughly 15,000 books had actually been printed, which closely matched the number of books Saxon authorized for distribution by Blann." The number was 1,000 and was repeated often enough for any interested examiner to know it.

Plaintiff's California-based attorney

had moved to disqualify Judge Waters. (Exhibit E.)

In denying the disqualification, the Appellate judges ruled, "Saxon did not file an affidavit stating the facts and reasons for recusing Judge Waters ten days before the trial began, and also failed to show good cause for not doing so.

The trial was without jury so Plaintiff's attorney had no idea of Judge Waters' prejudice against Plaintiff until he made his ruling months later. Plaintiff had every reason to believe Judge Waters would be objective. Long before the suit, Plaintiff had discussed the charges with Norman Stevenson and Lonnie Cox of the FBI. Stevenson advised Plaintiff to make it a civil rather than a criminal case.

When Plaintiff learned Judge Waters was to preside, he told agents Cox and Stevenson. Both affirmed that Judge Waters was a very fair judge, having ruled against them on occasion. Plaintiff also discussed Judge Waters with his bankruptcy attorney, Claude Jones. Jones told Plaintiff that to the best of his knowledge, Judge Waters had always ruled in favor of the copyright holder in copyright cases.

Not being a member of CSA or affiliated with any radical group, as Judge Waters obviously believed him to be, Plaintiff had no idea of Judge Waters' connection with such people.

Plaintiff's attorney stated in his request for disqualification, (Exhibit E-2), "If council for Plaintiff had been aware of past contacts of Judge Waters with CSA and Survivalists, every attempt would have been made to move the matter to a different Court; and it is hard to imagine any such attempt would have been unsuccessful."

The reasons for Plaintiff's attorney's failure to file an affidavit for disqualification ten days before the trial and the causes for not doing so were self-evident. The appellate judges were simply unconcerned and inattentive to the facts.

After Judge Waters' rulings, Plaintiff visited attorney Mike Yarbrough, a former close associate of Judge Waters, in his Springdale office. Yarbrough told Plaintiff and his wife that Judge Water's clerk, whom he had given the case to research, had found mostly for the Plaintiff. Judge Waters ordered that Plaintiff was to get nothing. They argued but since the clerk was only a woman and had to obey, she rewrote the Memorandum Opinion to conform to Judge Waters' prejudice against Plaintiff and for DP&L, Harper and Blann.

Yarbrough further related another instance when Judge Waters used his office to punish a litigant he disliked.

Of course, this is hearsay. But Plaintiff did not have the frame of reference to make up such a story.

So here we have a case whereby a citizen was denied the protection of his nations' laws simply because he did not belong. He was not in the mainstream of social thought. Plaintiff had never sued nor been sued and so had no experience with the court system. He knew little of the rules of evidence, although the evidence presented

was comprehensive.

Plaintiff's attorney was a California corporate lawyer, inexperienced in trial law, although meticulous at research.

Judge Waters' Memorandum Opinion was repetitious with "Plaintiff failed to prove this and that; Plaintiff's evidence did not show this and that, Plaintiff did not produce this and that," etc.

But it did not matter what Plaintiff, or council for Plaintiff did or did not present to Judge Waters on October 2, 1990. The case was decided in favor of DP&L, Harper and Blann from the outset.

It did not matter what council for Plaintiff did or did not present to the Court of Appeals. A brother judge had to be favored, even above the law.

Plaintiff failed because he was not one of the in-crowd and did not endorse the system. His proof, his evidence, was irrelevant because DP&L, Harper and Blann of Delta Press represented the mainstays of the system Judge Waters served. This is the stuff that makes revolution. The law is for everyone or the system is in jeopardy.

GLENN M. CHRISTIANSEN



Young Tracy just raises the safety bar to take her seat in swing. Support ropes pass through all parts holding them in place

How to make this spill-proof swing

All the parts forming this swing seat hang in place without need for nails or screws. The $\frac{3}{8}$ -inch hemp ropes thread through the parts, then loop back up and are spliced in about 3 feet above the seat. C. T. Morgan made the swing for the Robert C. Mahers, of Spokane.

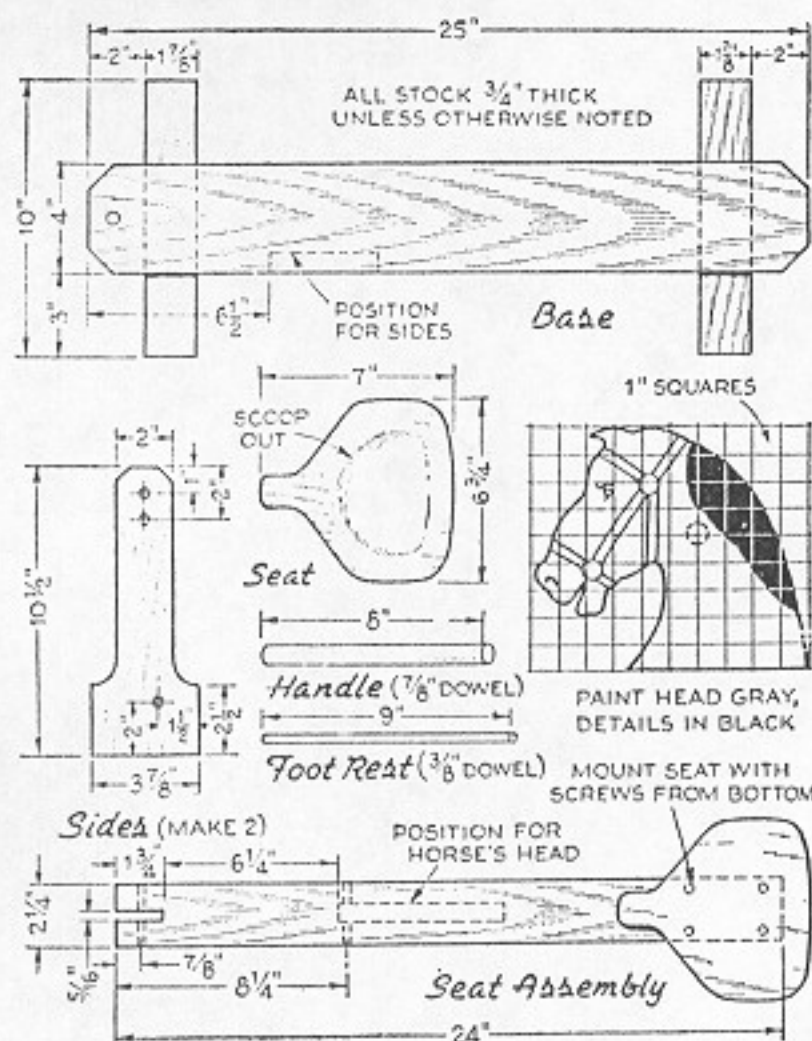
To make the swing, you need these parts, all with $\frac{3}{8}$ -inch holes: a seat of $\frac{3}{4}$ -inch plywood, 14 by 18 inches (glue $\frac{1}{4}$ -inch oak stiffeners to underside ends where rope passes); 4 dowel posts, $1\frac{1}{2}$ by 5 inches; 2 arm rests, 1 by 2 by 14 inches; and front and back bars, 1 by 2 by 18 inches. Assemble as photographs indicate.

Sunset September, 1960



Spill-proof swing, safe for toddlers, is large enough to last—and sturdy enough to survive—several years of growth

Muscle-Building Bronco Toy Thrills Small Children



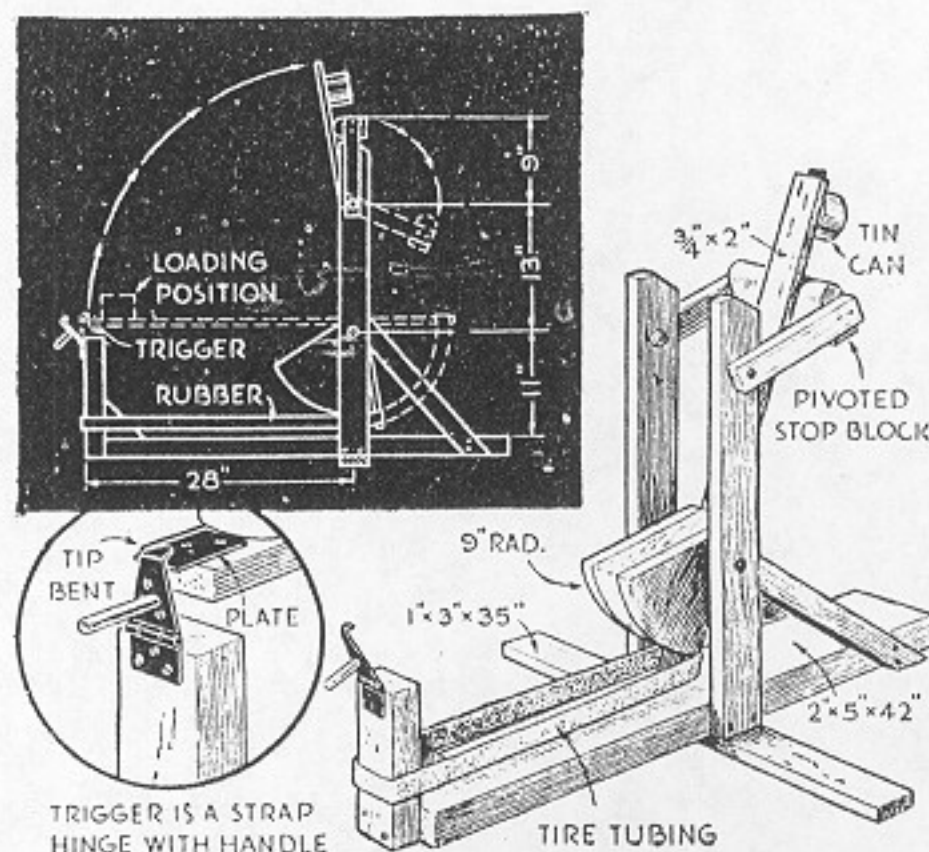
GIANT HOME WORKSHOP MANUAL 1941

CHILDREN up to four years of age can get lots of fun and exercise with this bucking-bronco toy. Make the parts as shown and assemble with screws from the bottom up so they do not show. The 9" length of $\frac{3}{8}$ " dowel used for the foot rest should extend equally on each side and be

glued in. The handle is a thicker piece glued securely in a hole in the horse's head. Bevel or sand all edges except the bottom of the legs. Attach the top board between the side panels with a bolt.

The spring, which can be obtained at almost any large hardware store, is attached to the baseboard with an eyebolt and at the top with a bolt through the front end of the seat assembly, which is cut out to allow for the upper loop of the spring.

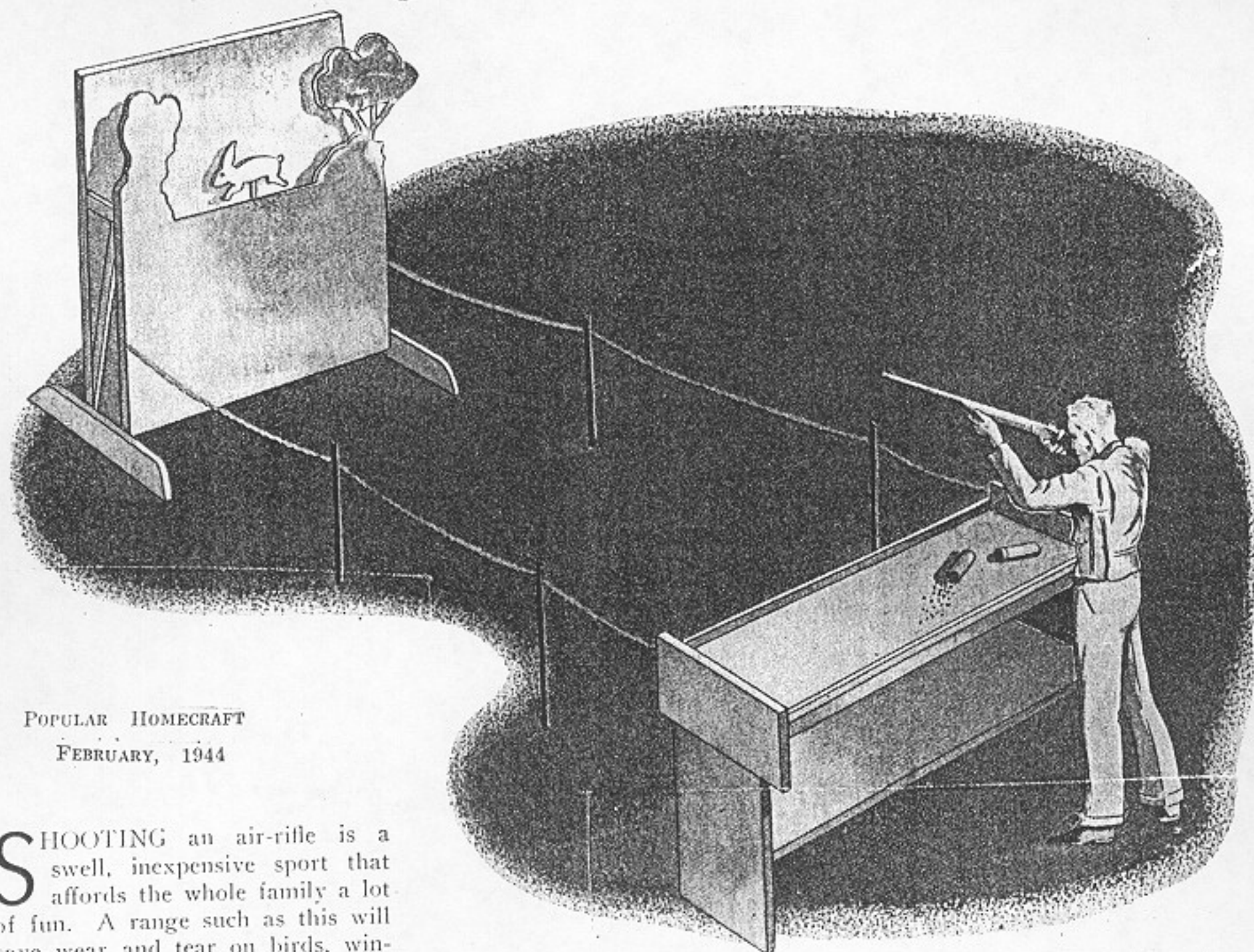
A good color combination is red with the horse's head in gray and details in black. The inside of the mouth and the handle are red; spring and bolts, black.



Catapult for Snowballs

SNOWBALL battles are much more fun when the skirmishers are supported by heavy artillery in the form of catapults. Scrap materials can be used in making the type illustrated, and a rubber band cut from an old inner tube will provide all the power necessary. When the strap-hinge trigger is pulled, the arm flies up until it hits the ejector block, which, it will be noted, is pivoted so that it swings down when struck, in order that no damage will be done to the arm. Brace the up-rights as shown in the drawing. The catapult can be aimed by blocking up the supports as necessary, and is harmless provided that only soft snowballs are used.

A Shooting Gallery For Air Rifles



POPULAR HOMECRAFT

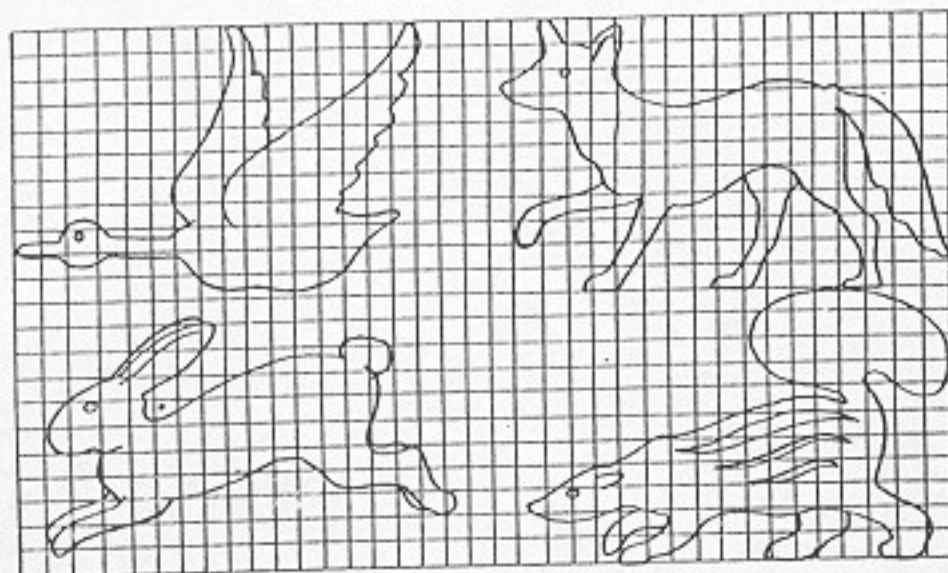
FEBRUARY, 1944

SHOOTING an air-rifle is a swell, inexpensive sport that affords the whole family a lot of fun. A range such as this will save wear and tear on birds, windows and other objects, and at the same time improve your aim on moving targets. The cost of construction is small, and gravity, free to all of us, supplies the power.

An inexpensive wall board nailed to wooden frames forms the front and back walls; between them is suspended the revolving disk with the cut-out animals on an axle, taken from a coaster wagon. To the end of each of the four wooden spokes a cut-out rabbit, duck, skunk or fox is hinged in such a way that when struck with a BB shot it topples over backward. It rights itself at the bottom of the revolution simply by gravity and remains in that position until hit again. Wide blades or vanes of wallboard attached to the spokes act as a brake against the

COLORS
 DUCK — GREEN AND BROWN
 RABBIT — FAWN AND WHITE
 FOX — RED
 SKUNK — BLACK AND WHITE STRIPES

LAYOUT IN $\frac{1}{4}$ " SQUARES
 AND SCROLL-SAW FROM $\frac{1}{8}$ "
 HARD PRESSED
 WALLBOARD



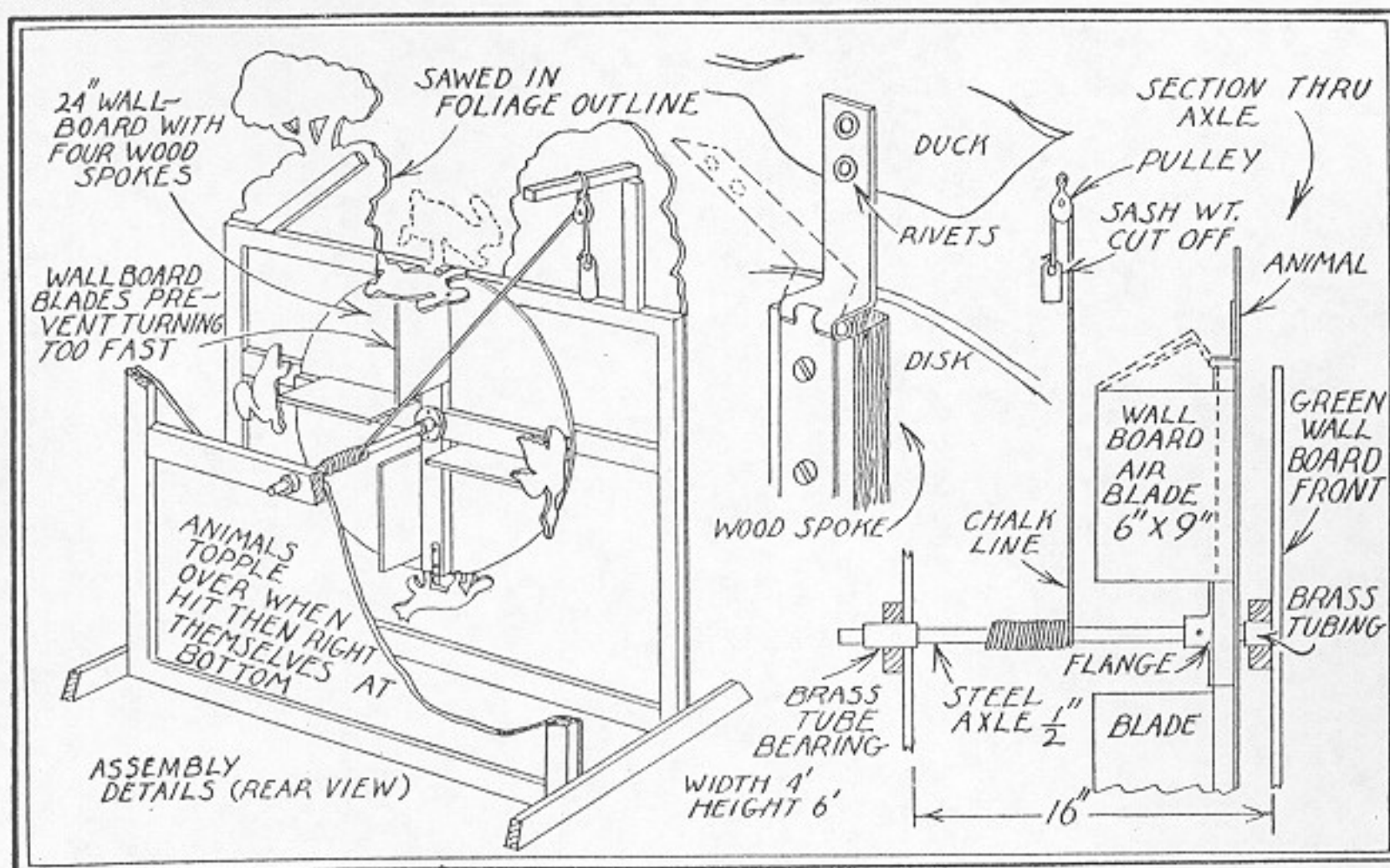
pull of the weight on the axle. The speed of the disk can be governed by the area of these and by the size of the weight. It is important that the disk be balanced as accurately as possible, and this is done by attaching a block of wood to the lighter side. Brass tubing makes a smooth bearing and reduces friction.

A thin, hard wallboard ($\frac{1}{8}$ in. tempered Masonite recommended) is best for the scroll-sawed animals because it does not split and will withstand many volleys without becoming badly battered.

Paint the exposed portion of the rear wall a very dark green; the front with the foliage a lighter

green. The animals in natural colors will then be sharply visible.

The disk will make about forty revolutions before the weight reaches the ground, and is rewound by hand simply by turning the disk in the opposite direction.



You can grow your own sponge

SUNSET APRIL 1961

The dishcloth gourd or sponge gourd (*Luffa cylindrica*) is a garden novelty plant whose dried fruits make good bathing sponges and scrubbing pads. On a recent trip to Mexico, we saw many vines growing in patios to produce gourds for use in the home. Last year we were reminded of them again by the display pictured below.

The vines bear cylindrical gourds between one and two feet long. The usable sponges are the fibrous insides, dried, with seeds removed.

How to grow: Sow seeds in April or when the ground is warm. (They may be a little temperamental and not start quickly.) If the growing season is short,



The seed, leaves, fruit, and dried fiber of the dishcloth gourd.

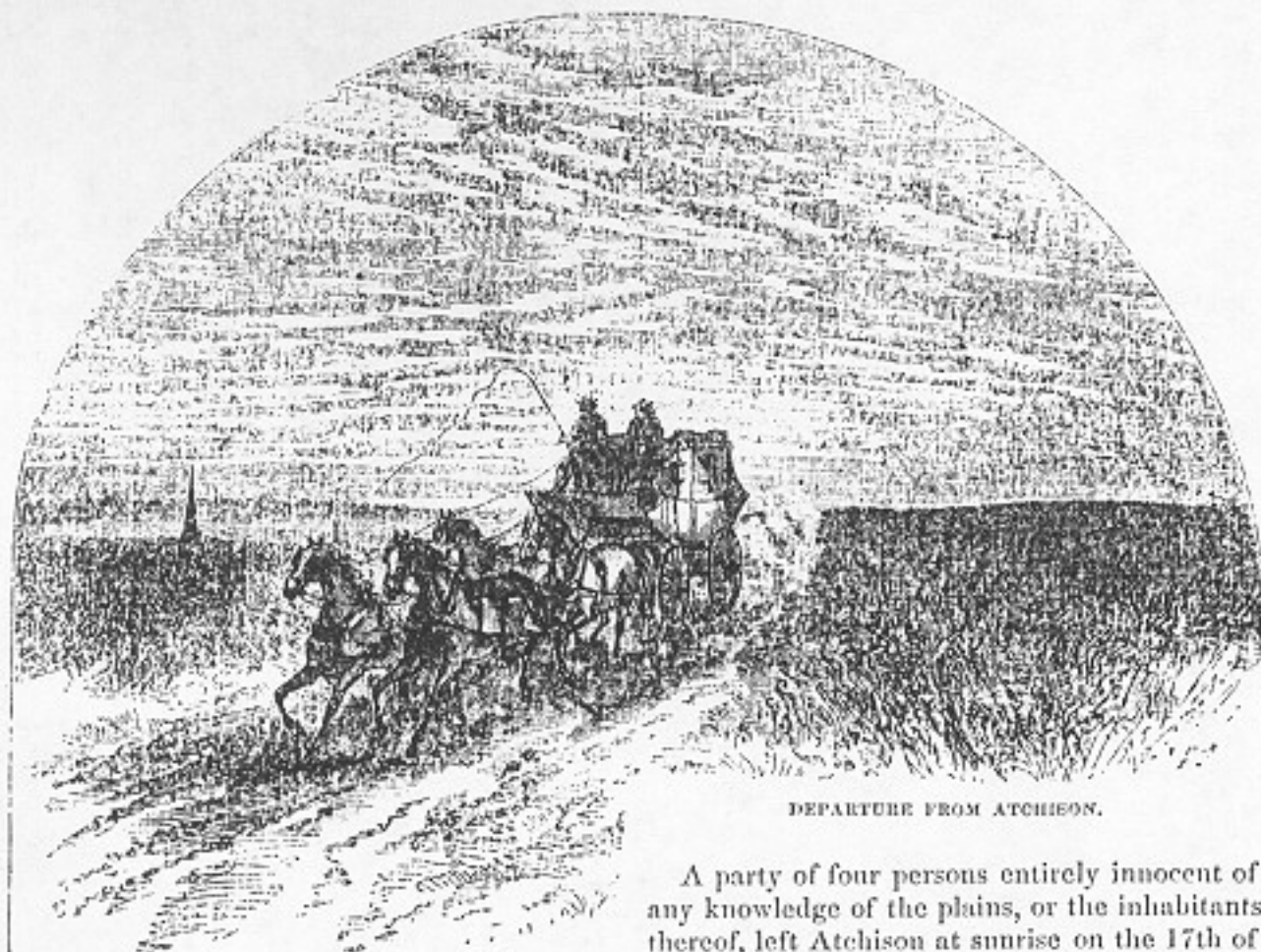
start seed indoors in small pots, in a fast-draining peat moss, sand, and soil potting mixture. Plant seedlings two feet apart. Plant in full sun. Gourds need all the summer heat they can get to develop

fruit by first frost. When you plant for a gourd harvest, give vines a wire fence support so that the gourds are held up off the ground. Once the plants are started and underway, give them regular deep watering during the entire growing season.

How to harvest: To get a good white sponge, harvest gourds when the skin begins to turn yellow. Cut the stems so that you can hang them up to dry. Don't rush the drying by exposing to the sun or by oven-baking. Peel the surface of the vegetable sponge while still green and push out the seeds in the fiber by hand. Wash out the tissue in the fiber and dry.

After drying, cut the dried fiber into halves or thirds for easier handling as a scrub brush, or leave it full length for larger cleaning jobs.

You can obtain seeds from most garden seed catalogues.



DEPARTURE FROM ATCHISON.

HARPER'S NEW MONTHLY MAGAZINE.
JULY, 1867.

A STAGE RIDE TO COLORADO.

by Theodore R. Davis

THERE are three routes or wagon roads across the plains to Colorado—the Platte, or as it is usually designated, the "Northern Route;" the Arkansas or "Southern Route;" and the Smoky Hill or "Middle Route."

Of these routes the Smoky Hill is by far the most interesting, though not usually considered the safest, its course being directly through the favorite hunting-ground of several of the most warlike tribes of Indians on the plains. Disturb the game and you make the Indian "heap big mad," in which state he is not to be held accountable for any little indiscretion in which he may indulge. The Platte route has been established for a number of years. The traveler has many advantages by it not afforded over a newer route. It is longer, however, than the "Smoky," which is the most direct road to Denver yet laid out across the plains. A majority of the early pilgrims to Pike's Peak made use of this trail.

In 1865 a company was organized under the title of "The Butterfield Overland Dispatch," which at once undertook the establishment of an express and passenger line from Atchison, Kansas, to the city of Denver, a picturesque town near the base of the Rocky Mountains.

The Concord coach used for the conveyance of passengers on the overland route is so arranged that nine persons may be crowded into it and seated. When so packed, and a journey of more than six hundred miles is to be undertaken, the passengers are said to be "accommodated." They certainly are "to circumstances." This packing may be avoided by securing a special coach, which can be done at a reasonable rate.

A party of four persons entirely innocent of any knowledge of the plains, or the inhabitants thereof, left Atchison at sunrise on the 17th of November, 1865. Their "outfit" (in the language of the plains this word signifies the conveyance, its contents, and the team) consisted of a Concord coach painted to a degree of redness that could not fail to attract the attentive consideration of the un-read men of the country into which four spanking steeds, driven by a Jehu who had never "upsot an outfit," were rapidly rattling us.

The "boot" and "shoe" of the coach contained a moderate quantity of necessary baggage and a comfortable supply of rations. Each of the party had provided himself with a Ballard rifle and a pair of navy revolvers, a pair of blankets, tobacco, a brier-wood pipe, and a stout sheath-knife such as is used by our men-of-war-men.

One of the party had an assortment of beads, small mirrors, and a few books filled with brightly-colored pictures. These he fondly hoped to exchange with Indians for many bows and arrows, a few tomahawks, and a scalping-knife. Another was prepared to pre-empt large tracts of land when he should discover a location entirely satisfactory to him. "A coal mine would be rather good," he remarked; "sell it to the Pacific Railroad people when they get their road out there." The price of hay, condition of stock (mules and horses, not Eric), and the progress made in the construction of stations, was the subject under consideration in the mind of the third, he being the Vice-President of the company over whose route we were traveling. The remaining member of the party—the writer hereof—was located on top of the coach in quest of such information as the Jehu might be willing to impart with reference to Indians, buffalo, antelope, and coyote.

Jehu divulged freely, the brass cap of a field-glass being mistaken by him for the top of an affair used to contain a something by means of which it is easy to see double—a whisky flask. "How far do you drive?" we inquired; to which he responded, "The drives is forty mile from home-station to home-station.

Thar we changes drivers. Stock-stations be some twelve mile, and some fifteen. We'll get a hoss team next; then mules, till you get near Denver. Much good lickin' in the States?" eyes on the top of the glass. "Nips this mornin'g? Like one myself!"

His effort at a joke was communicated to our friends inside the coach, and met with a prompt response in the form of a flask of goodly proportions. The production of this was imprudent; for the fact of its possession was communicated from driver to driver until the most energetic squeezing could not discover a wee drop more.

Smacking his lips and his whip at the same moment—tokens of his appreciation of the situation—our driver became once more communicative. "Deers you're like to see this afternoon; buffalo to-morrow; an' Injuns! you bet you get enough of in two days from now if what the fellers say what's just come in is plecters, an' they knows!"

Cheerful stories of the habits of the "gentle savage," and his method of showing contempt for his white brother, now followed. The contemplation of our chances for similar treatment did not present any very flattering prospect to our westward gaze.

We had by this time arrived at the first station out, a comfortable frame house of one story. At a little distance from it was a good stable, near which were great stacks of prairie hay. Evidences of thrift, too apparent to escape observation, pervaded the place. It was the Kansas home of a New England man. The land about it was a rolling prairie. The soil as rich as a garden.

"Yip! yip!" from the driver announced his readiness to proceed, fresh stock having replaced the team with which we left Atchison. We were now fairly started on our journey. Long trains of "prairie schooners"—a name by which the plainsman designates the huge canvas-covered wagons used for the transportation of freight across this ocean of land—were passed so frequently as to become too familiar to occasion remark. The trains give a picturesqueness to the plains that greatly enhances the journey across.

The wagons are generally doubled up—that is, the tongue of one wagon is passed beneath the body of the wagon next preceding it, and then securely lashed. Eight or ten yoke of oxen, under the lash of a "Bullwhacker," is the motive power furnished each double. This arrangement enables the wagon-master to handle his train with a smaller number of men than would be possible if each wagon had its separate team. By the side of each wagon hangs a musket or rifle, ready at hand in case of need, either for Indians or buffalo. Over the tops of the wagons are thrown the red blankets used by the teamsters for cover at night.

Beside the first yoke of oxen trudges the character of the plains—a Bullwhacker. Usually he is a well-built man, bronzed by constant exposure to the weather; his hirsute and unclean appearance indicating a cat-like aversion to water. He is more profane than the mate of a Mississippi River packet, and, we have his word for it, "ken drink more whisky." Accompanying this assertion were seven of the most astounding oaths that ever fell on an ear used to the strong language with which the army teamster encourages his mules. The Bull-

whacker's oaths and his whip are both the largest known. The handle of the ordinary whip is not more than three feet in length; the lash, of braided rawhide, is seldom less than twenty feet long. From the staff the lash swells gradually for five or six feet, when it reaches a size of at least ten inches in circumference; from this point ("belly" is the term used here) it tapers to within a foot of the end, which is formed of a ribbon-shaped thong. With this persuader the cattle travel eighteen or twenty miles a day. A lazy ox occasionally receives a reminder, in the shape of a whack in the flank, that causes him to double up as if seared with a red-hot iron. The blow is invariably accompanied by a volley of oaths that seems to startle the whole team into a more rapid pace.

General Sherman tells a story in defense of the extremely profane mule-drivers who kept his trains so well closed up during the long marches of the army under his command. It is to this effect: One of the members of a freighting firm in St. Louis desired to discourage the continual blasphemy of the Bullwhackers in their employ. Orders were accordingly issued to their train-masters to discharge any man that should curse the cattle. The wagon-masters were selected more for their piety than for any extensive knowledge of their duties in the handling of trains. The outfit had not proceeded more than a hundred and fifty miles before it was stuck fast. A messenger was dispatched to the firm with the information that the cattle would not pull a pound unless they were cursed as usual. Permission to do this was requested and granted, after which the train proceeded to Salt Lake, to which place good time was made.

The accuracy with which the Bullwhacker throws his lash is astonishing. A favorite pastime among them is the cutting of coin from the top of a stake thrust loosely into the earth. If the coin is knocked off without disturbing the stake it is forfeit; if the stake is disturbed the thrower of the lash loses the value of the coin. A Bullwhacker, noted for the accuracy with which he threw his lash, bet a comrade a pint of whisky that he could cut the seat of his pantaloons without touching the skin beneath. The bet was accepted. The blow delivered at the stooping form of the acceptor of the wager, who is said to have executed the tallest jump on

record, at the sight of which the thrower of the lash remarked, "Thunder! I've lost the whisky!" The other party was minus a strip of skin as well as a large fragment of breeches.

The depredations committed on the stores with which the wagons are loaded are often very heavy, especially when wines or liquors form a portion of the freight. It is difficult to imagine a more perfect pandemonium than a corralled train presents at such a time. The value of the articles thus disposed of is deducted from the wages of the wagon-masters as well as the Bullwhackers.

Just at nightfall we arrived at the St. Mary's Mission—the Pottawatomie Reservation. Supper was provided for us in a room, the walls of which were hung with white-washed canvas. Although we did not leave the settlements until the following evening the supper at St. Mary's



A BULLWHACKER

was the last meal that we could regard as civilized.

The first night in a stage-coach is undoubtedly the most uncomfortable. As soon as night falls passengers evince a desire to make a noise. Conversation quickly gives place to song. This night our songs were of home, and our wandering thoughts annihilated the long miles between our rumbling coach and the bright firesides on the Atlantic coast. The drowsy god soon spread his wings among us, knocking the pollen of the poppy into our eyes to an extent that caused a general remark of bedtime. What a misnomer under the circumstances!

Sleeping in a stage-coach is not the most desirable method of passing the night, although it is far preferable to the deep mud of the battleground in which we have slept soundly more than one night. Campaign life certainly educates a person in the art of sleeping, and assists a quick selection of the best location for blankets. The "shoe" of the coach was not available owing to the quantity of baggage stowed therein. The top presented a prospect for longitudinality if an arrangement could be projected to prevent being rolled off. That such a desirable fact was established may be known by the statement that the present writer slept on the top of the coach during the rest of the trip while traveling at night. The rest of the party disposed themselves as best they could inside, and complained of cramps.

The second day was almost without incident. We were traveling through a rolling country entirely destitute of wood. The grass, though snow had fallen and disappeared, was still high, and in some places almost green. Drove of black-tail deer were seen occasionally; but none near enough for a shot until late in the afternoon, when one of the party succeeded in bringing down a fine buck, whose saddle was quickly pitched into the shoe with the remark that we should have venison for supper.

At evening we passed Fort Ellsworth. By sunrise we were in the Buffalo Country. The grass was no longer high, but short and thick as closely-shaven sod. Tracks of innumerable herds were visible every where. A net-work of trails and paths seemed to cover the plain as far as the eye could reach. "Buffalo chips" were scattered in all directions. What better sign could we have of the presence of game? Who was to kill the first buffalo was now the topic. Each was certain of the first if he could only get a shot.

The "Yip! yip!" of the driver sounded wilder as we came to the next station. We were in the Indian country, and half fancied that a yell of such unearthliness could only have been learned from a native whose best garments consisted of the brightest paint. The station was yet to be built. At present a cave dug in the side of a hill, near the sink-hole from which water is obtained for stock, served for the two stock-herders who were content to abide therein for twelve dollars per month. The mules that were to be our next steeds grazed unpicketed at a short distance from the station.

While the stock was being driven up we set to work to prepare breakfast. One of us went to request a little wood from the stock-herder. The demand was met by a prolonged W-h-a-t! that conveyed extreme surprise. "Want to make a fire, eh? Get chips, then."

"Where are they?"

"Why, stranger, don't you see 'em all over the country?"

A glance at the fire smouldering near solved the mystery. Buffalo "chips" were the substitute for wood. So, comprehending the situation, our chip-gatherer, bag in hand, departed to secure the necessary material with which to build our fire.

I am not Professor Blot; but yet consider myself a cook of no mean order. There is not a section of the country in which I have not hunted or fished, making use of the best means at hand to cook the game thus secured. This

experience entitles me to consideration when I affirm that there is no better broiling fuel than a perfectly dry "buffalo chip."

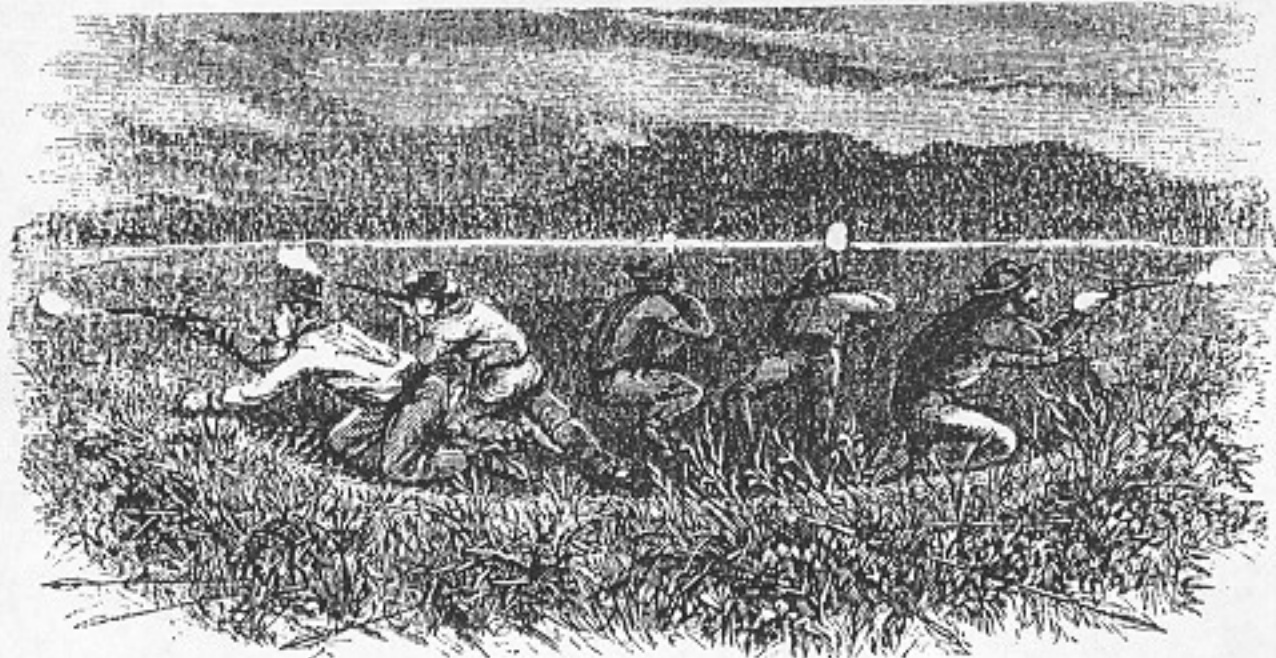
That a doubt arose, as the smoke curled up from the newly-lighted pile, as to the judiciousness of depositing a juicy venison steak on those coals, it is useless to deny. The appearance of a bright red coal with an ash of almost snowy whiteness soon became apparent. The steak was quickly deposited on the fire, notwithstanding the expostulations of the chip-gatherer, who would have found a gridiron if such an article had formed a portion of the culinary furniture of the stock-herder's cave.

The air of the plains is a wonderful appetizer. A cup of good coffee, steaming hot, is a good foundation. Venison steak, baked potatoes, and a hot corn-dodger composed the bill of fare. This disposed of, the pre-emptor of wild land proceeded to remove the dishes, the Vice-President to arrange the blankets and other contents within the coach, and thus our experience in the buffalo country was commenced.

The generally-accepted idea is that the plains, like the prairies, are perfectly flat, unbroken stretches of land. This is not the fact. They are rolling, and broken by innumerable gullies or cañons, through which the flood poured by the great rain-storms escapes to the creeks or, as they are dignified, rivers. Traversing ground of this character it is frequently possible to approach game that would have taken fright some time before you were sufficiently near for a shot had the ground been as level as the prairie.

Thus it was with the buffalo. We had seen them in the distance for some hours, but always too far away for our purpose, as we could not leave the coach to make any very considerable detour. Suddenly we came within sight of a considerable herd but a short distance from the road in advance of us. The coach was stopped at once, and by careful approach through cañons, the party reached a point within easy rifle-range. A fusillade was opened on the nearest of the herd, a huge bull, who, as the bullets hit him, expressed his contempt by a twist of the tail or shrug of the back. The number of leaden pills was too considerable for his thick hide and robust constitution. Down he came with a vigorous bellow as his death-song. The tongue, tenderloin, and a portion of the hump was quickly cut out, and the rest of the carcass left for the consideration of the coyotes that follow each herd of buffalo. Experience is, in buffalo-hunting as in many other things, the best teacher. We soon learned that a buffalo may be shot down by driving a bullet through the flank just under the back-bone; once down he is easy game.

During the first day in the Indian country we saw thousands of buffalo, and for days they were continually in sight. To estimate their number would be impossible. It is said that they are rapidly decreasing in number, but that would seem impossible. The herds move in regular order, the cows and calves occupying the centre, and the bulls ranging themselves on the outside. In this way the wolves are kept off. But the coyote is patient; he lives in hope, if he has an empty stomach. He watches continually near the herd, keeping a respectful distance from it, however. A sick or wounded buffalo leaves the herd, or is left behind in its movement. The coyotes are about him in a



FIGHTING FROM A WALLOW.

moment, all prepared to do full justice to his juicy meat. But the gray wolf does not permit this; he is the largest, and insists on the first seat. His appetite satisfied he retires, and permits the coyotes to pick the bones. By this time a number are collected to join the feast; ravens are hovering over the spot, swooping occasionally to seize some fragment. Like an Irish wake, this feast invariably ends in a fight, in which the coyotes alone participate. The size of the gray wolf seems to protect him as he sits admiringly gazing at the row.

As soon as a bull becomes old he is driven out by the younger males, and not again permitted to join it. These old fellows may be seen wandering over the plains singly, though occasionally four or five will herd together, seemingly to protect themselves from the coyotes, that are now become persistent and familiar in their attentions. They are evidently in haste to attend a feast that will be certain to occur at the funeral of the aged bull.

The plains are dotted with circular cavities of ten or twelve feet in diameter, known as "wallows." To these the buffalo resorts to roll, covering himself with a coat of moist earth, that he seems perfectly aware will discommode the lively inhabitants of his shaggy coat.

During the afternoon we reached Fort Fletcher, a newly-established government post, garrisoned by a force of three hundred men, under the command of Colonel Tamblin. The fort is so in name alone, as the work is yet to be built. A cotton-wood grove, a sort of an oasis in this treeless country, had been selected as a camp-ground, which was not only picturesque but comfortable.

From the Colonel we learned that the Indians were not troublesome—that is, they had not committed any outrages for a few days past. This was encouraging, and we continued our journey, congratulating each other on the prospect of meeting "friendly" Indians. We were not then aware that fifty miles in advance of us these very "friendly" persons were at the moment engaged in the neighborly employment of roasting two poor fellows who had fallen into their hands. An Indian, like a rattlesnake, may be trusted only when his fangs are removed; otherwise it is well to give him a wide berth, or be prepared to kill him on sight.

At sunset we arrived at Ruthden Station, 22

miles distant from Fort Fletcher, where a cave similar to the one previously described served as an abode for the stock-tenders and made the station. A small train was camped here, water being plenty and the grazing good. Much of the waters on the plains is so strongly impregnated with alkali that the grass and weeds on the brink of the sink-hole containing the water are covered with a frosting coat. The water is said to be healthy, however, after it has been used for a sufficient length of time to accustom the system to it. Any way, fair coffee can be made with it. Sunset this evening was the most gorgeous that we ever witnessed. The western skies were gold, then crimson, with the brightest of golden ripples threading through. As they purpled with the twilight the crimson became fire. The splendor of color was dazzling. Boosters of the glory of Italian sunset, see through the pure air of this wonderful country the choice colors spread at sunset in the skies of our Western plains, and you will convince yourselves that not until that moment have you seen old Sol retire in his imperial robes.

At Ruthden a discovery was made by one of the party. The stock-tenders were using roots to wash with. The root of the soap-weed, or amola, as it is commonly designated, is an excellent substitute for soap. For washing woollens it is particularly valuable, as it cleanses without shrinking them. We will advertise it. "No family should be without it," unless there are boys growing up, when the shrinking of a flannel shirt causes its regular descent from father to son, and so down to the two-year old, for whom it is a good fit after a few months experience of the modern improvements—hot and cold water.

Our repast of buffalo steak and et ceteras disposed of, we started off on our journey. As the darkness settled about us a feeling pervaded the party that all was not right. Conversation turned upon Indians. We heartily wished that it was morning. Shortly after midnight the coach stopped. "Turn out!" shouted the driver—"Indians!"

We were off the coach in a moment. A small body of men were visible advancing toward us through the darkness. Revolvers in hand, one of the party started toward the strangers, who

were discovered to be white men. From them we learned that the coach preceding ours had been attacked by Indians, from whom, after a desperate struggle, these men had escaped. The men were perishing with cold, and were out of ammunition. The Indians were in strong force, and evidently intent on their work of murder and destruction. All things considered, it was determined to return to Rathden and dispatch a messenger to Colonel Tamblyn asking for an escort. The coach was turned about, the newcomers having been made as comfortable in it as possible.

"More haste the less speed" was our fortune. In crossing a gully the king-bolt was displaced, making it necessary to unload the coach before it could be rearranged; while this was being done our chip-gatherer started off to find a rail. As there were none within a hundred miles he returned without it, but remarked that the coyotes were thick out in that section: from the noise that they were making he was evidently correct. The coach was repaired, and we proceeded on our return, during which we learned the story of our new passengers.

The coach had arrived at Downer's Station about two o'clock in the afternoon, one passenger, the messenger, and the driver being the occupants. At the station they found two stock-tenders, two carpenters, and a negro blacksmith. The mules were unharnessed and turned loose, when a band of mounted Indians charged, whooping among them; the men retreated to the cave, or "adobe," as they designate it. Indians came from all directions, and completely surrounded the adobe, the occupants of which prepared to fight. An Indian will never fight until he has obtained every possible advantage; then he makes a rush. A half-breed son of Bill Bent, the old mountain man, was one of the leaders of the Indians; being able to speak English, he managed to call to the occupants of the adobe that he wanted to talk. This was assented to. He came up and inquired whether the treaty had been signed. He was informed that it had, to which he replied, "All right!" They would have peace if the occupants of the adobe would come out and shake hands, leaving their arms behind, and the Indians would do likewise. The men came out, and a general hand-shaking followed. The Indian is great at this; he will shake your hand all day and at nightfall will take your scalp. It is simply a way that he has of expressing his brotherly sentiments toward the white man.

The Indians still further deceived the party by driving up the mules that had been stampered by them, telling the messenger that the coach should proceed without molestation. Such evidences of friendship disarmed the party of any suspicion of hostility, though the Indians were in full paint and without squaws. In a moment all was changed. The Indians turned upon the party—bows, arrows, and revolvers were produced, and a desperate attack at once inaugurated. The messenger, Fred Merwin, a very gallant young man, was killed instantly; others of the party were wounded, and the two stock-tenders captured. Mr. Perine, the passenger, the driver, carpenters, and blacksmith ran for the neighboring bluffs, which they succeeded in reaching. Taking possession

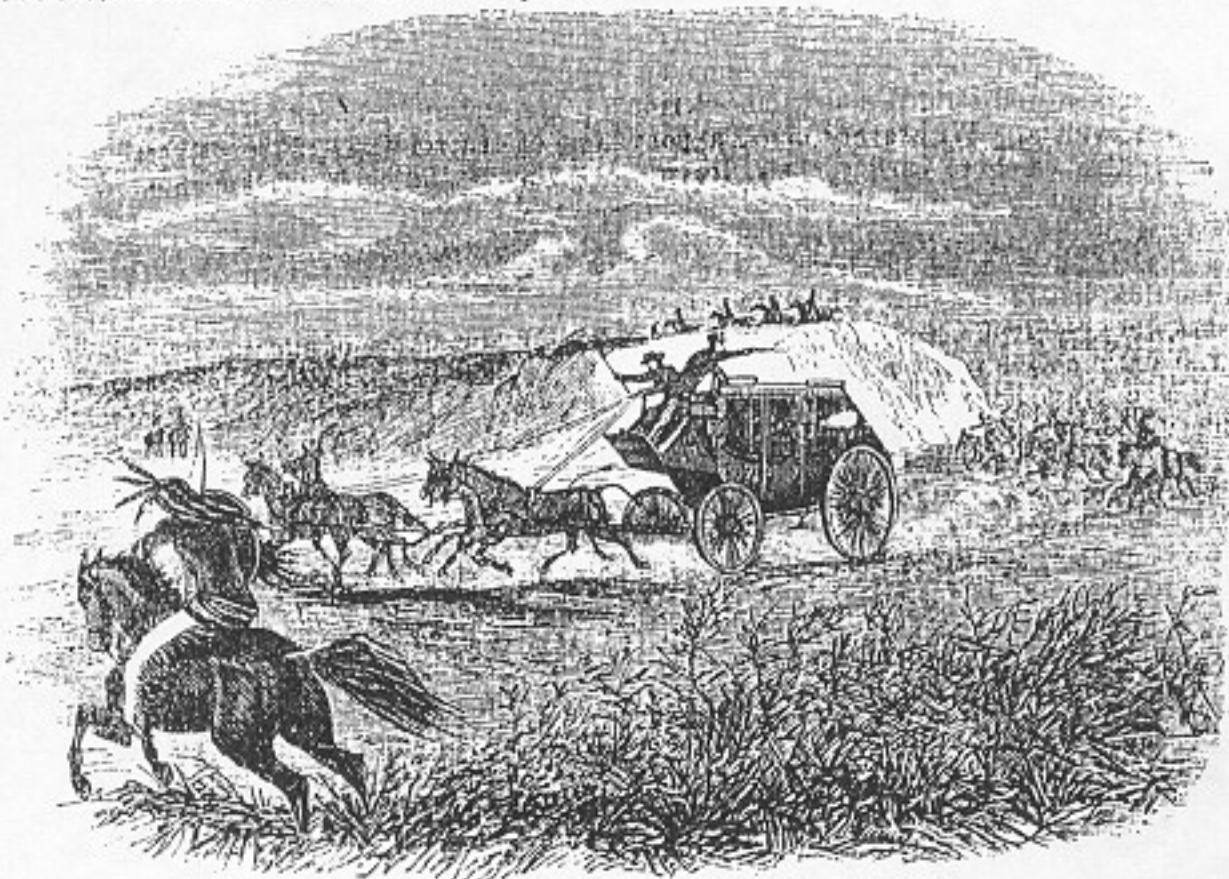
of a buffalo wallow they fought until nightfall, when the Indians withdrew, and they made good their escape.

Mr. Perine gives a very interesting account of the fight from the wallow:

"They formed a circle about us, riding dextrously and rapidly; occasionally one more bold than the rest would come within range of our revolvers, but he was careful to keep his body on the side of his pony away from us. Arrows came from all directions; a rifle or revolver bullet would whistle past us or strike the earth near. It was evidently their purpose to permit us to exhaust our ammunition, when they would be able to take us alive. Of this fact we were painful-

convinced of the fact we followed their example, going, it is unnecessary to remark, in the other direction. Chalk Bluffs we found deserted and the station burning. Then we heard the coach coming and came to it. The Indians would have probably taken you in if we had not."

We had by this time reached Rathden. Mr. Perin's narrative had made us particularly anxious to reach a point where we could have a chance of fighting without giving the Indians all the advantage. It was not yet daylight, but we made all arrangements for a fight if we should be attacked at dawn, as we fully ex-



HERE THEY COME!

ly aware, and only fired at them when we were sure of a good shot. This kept them at a distance. The negro blacksmith was armed with a Ballard rifle, with which he was a capital shot. He bravely exposed himself to obtain a shot, and came near losing his life by so doing. A bullet struck him in the head, when he fell, as we supposed, dead. I took his rifle, rolled the body up to the edge of the wallow to serve as a breast-work to shoot from, and commenced to fire. I had made several shots in this way, and had the rifle across his neck with a dead aim on an Indian when the darkey came to, and remarked, 'What you doin dar, white man?' thus discovering to us the fact that he was any thing but a 'gone coon dis time.' He had been deprived of speech and power of motion by the shot, but was fully aware of what was going on about him. He was not disposed to regard the use of his body as a breast-work as altogether a pleasing performance.

"While we were fighting from the wallow we could plainly see the Indians that still remained about the adobe, at work torturing the stock-herders that they had succeeded in capturing alive.

"One poor fellow they staked to the ground, cut out his tongue, substituting another portion of his body in its place. They then built a fire on his body. The agonized screams of the man were almost unendurable; about him were the Indians dancing and yelling like demons. The other stock-herder was shoved up to look at the barbarous scene, the victim of which he was soon to be, but they reserved him until nightfall, evidently hoping that we might be added to the number of their victims.

"There could not have been less than a hundred and fifty Indians in the entire party—that is, those who were about us and those near the adobe. Bent told us that Fast Bear, a Cheyenne chief, had command, but Bent is worse than an Indian, for he knows better. Had there been a possible chance to rescue the stock-herders we should have attempted it. When darkness came the Indians withdrew, and as soon as we were

pected. A messenger was dispatched to Colonel Tamblyn. The stock was picketed sufficiently near the corral of wagons to enable us to drive them into the circle. Our party were disposed at points sufficiently distant from the corral to give the alarm in case of danger, and we were ready to fight Indians.

This day, the 20th of November, passed without incident. Buffalo were in sight on all sides, but we considered the risk too great in hunting them. The quantity of Buffalo skulls scattered about the plains near this place seems remarkable. The coyote and gray wolf abound near here in greater numbers than we have before seen. At nightfall we discovered a welcome sight—soldiers marching toward us from the direction of the fort.

Very soon the Colonel rode up to us with a small escort of cavalry. A company of infantry soon followed and camped near us. For the time being our anxiety was relieved. The night passed quietly—that is, if we except some quarrels between the soldiers and coyotes that ventured into camp to dispute the possession of rations.

Governor Gilpin declares the coyote to be a sociable little fellow that serenades you all night, the gray wolf doing the baser portion of the musical performance. The Indian does not kill the coyote, as he regards him as his watch-dog. There is much truth in this, as the coyotes surround a camp at nightfall, and at nine or ten o'clock open a chorus that would in-

dicate the presence of a thousand or more instead of twenty or thirty. Let any one approach the camp, however, and the music ceases. Then it is time to be on the *qui vive* and keep away from the fires.

On the morning of the 21st we left Ruthden, but moved slowly to enable the troops to keep pace with us. Chalk Bluffs, a picturesquely located station, we found deserted and burned. What strange convulsion caused this strange crag-like mass? It rises from the plains like a vast castle, fashioned by the most ancient of architects. A fine spring, the water of which is strongly impregnated with magnesia, is located here. We could find no trace of any fight at this place, and conclude that the herders have escaped or been carried off by the Indians.

In the afternoon we reached Downer's. The devastation here has been complete. The coach, and every thing that would burn about the station, was destroyed. The ground was every where tracked over by the unshod hoofs of the Indian ponies. We could not find a trace of the bodies of Merwin or the stock-tenders; neither could we account for their disappearance. Mr. Perine, who had now become one of our party, was at loss to know the reason, as he was confident that Merwin was killed at the first fire, and he very sagely concluded that men that underwent the torture inflicted on the stock-tenders were not likely to live but a very short time.

We break camp at daylight. A few miles from Downer's we found a body, or rather the remains of a man, evidently killed the night before. The wolves had stripped the bones of all flesh; face, hands, and feet alone were unmarked. As we came near the wolves with-

it leaves the skin by the handful.

The stations thus far had been deserted. We were unable, however, to discover any signs of Indian visitation. Wolves were abundant. The soldiers were arranging poison traps for them. Slices of buffalo meat, in which strychnine had been inserted, were placed upon small stakes set up at a short distance from camp, seemed to be the favorite method; but one old soldier had taken a quantity of marrow and mixed strychnine with it. This he was rubbing into a number of auger-holes in a board made for the purpose. The deadliness of the poison may be imagined by the fact that on the following morning he found four dead wolves within ten feet of his trap.

At noon the next day we reached a station where we found a Government train corraled. The Indians had attacked the train and driven off a number of the mules. One soldier had been killed, and another shot through the neck with an arrow and scalped, having feigned dead while the Indians were engaged in "lifting his hair." His wounds were not considered serious, but the doctor says that he will have a bald spot on the top of his head. A coach was here on its way east.

The mysterious disappearance of the bodies of Fred Merwin and the two stock-tenders was accounted for. The train corraled here, passed Downer's the morning following the massacre, and buried the bodies, beating down the grave to prevent resurrection by wolves. Here Colonel Tamblyn left us, considering it safe for the coach to proceed with an escort of five cavalrymen.

One of our party returned with the Colonel to convey the body of his late friend Merwin to the States. We afterward learned that he reached the States in safety after three different fights with Indians, in which, with his Ballard rifle, he took no mean part.

"The Monuments" were reached this evening; near them is a camp of more than two hundred soldiers. A fort is to be built, also a station. These Monument Rocks are considered the most remarkable on the plains; at a distance it is difficult to realize that they are not the handiwork of man, so perfectly do they resemble piles of masonry.

The wind that night was terrific. Two tents were blown away, and a wagon that was not brought into the corral overturned. The mules stood with their backs to the blast, that caused their hair to stand out like fur.

The air of the plains is glorious, pure, and dry—consumption is not known. There is no odor to a dead body, as it does not decay but simply dries up. Men of fair education and some property may be found driving coaches. They have left the Atlantic coast, given up by physicians as in the last stage of consumption—a fact that would never be mistrusted from their present robust condition. There seems to be a strange fascination in stage-driving. Though it is one of the most toilsome of lives, a man once located on the box of a coach seldom or never leaves it for any other employment.

We left Monument early on the morning of the 25th to continue our journey. An ambulance, containing a surgeon and four men, accompanied us as well as the escort of five cavalrymen. The next station was twenty-two

miles distant. Our road lay over a picturesque country in which buffalo and antelope were more than abundant. The antelope on the distant slopes reminded one of vast flocks of sheep.

By eleven o'clock the driver pointed out the station. "Thar's Smoky Hill Springs—purty place, ain't it?" When within half a mile the ambulance left us, taking a short cut to the road on the other side of the station, which was located for convenience to water at some distance from the direct route. The cavalrymen galloped on to the station, which they reached, while we were some distance from it.

When within two hundred yards of the adobe we glanced back to see the country over which we had passed, and discovered, within sixty yards of the coach, a band of nearly a hundred mounted Indians, charging directly toward us. The sight, frightful as it was, seemed grand. "Here they come!" and the crack of a rifle was responded to by a yell, followed by the singing whiz of arrows and the whistle of re-

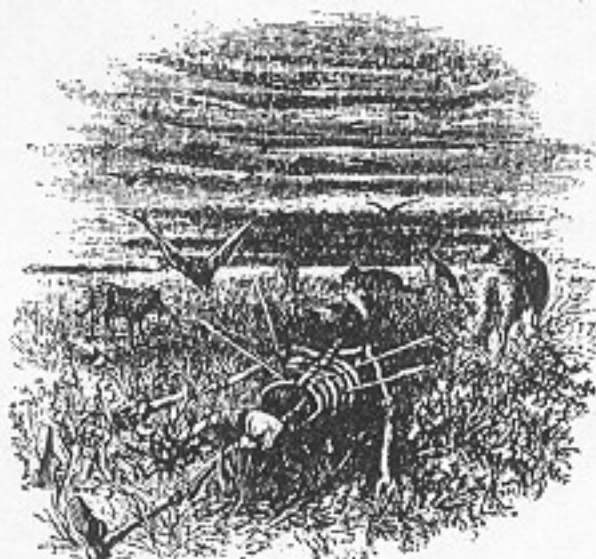
volver bullets. The first shot dropped an Indian. Next a pony stopped, trembled, and fell. The driver crouched as the arrows passed over him, and drove his mules steadily on toward the station. The deadly fire poured from the coach-windows kept a majority of the Indians behind the coach. Some, however, braver than the rest, rushed past on their ponies, sending a perfect stream of arrows into the coach as they sped along. We were by this time in front of the station. The cavalrymen opened with their revolvers, and the Indians changed their tactics from close fighting to a circle. One, more daring than the rest, was intent on securing the scalp of a stock-herder whom he had wounded. He lost his own in so doing.

The first brush was over. A dash was made to secure the body of the fallen brave, but given up as soon as it was evident that he had lost the top of his head. Indians have strange ideas with reference to a scalp. The body of a scalped brave is neglected; he can not enter the happy hunting ground with a bare head, so no trouble is taken to bury him. The ravens and coyotes save the trouble. Plainsmen tell you that "coyote will not eat Indian." This we do not believe.

From the adobe we discovered a sight that was not to be looked at quietly. The four mules attached to the doctor's ambulance were flying across the plains at a dead run. Indians enveloped the ambulance like a swarm of angry hornets. The men in the ambulance were fighting bravely, but the Indians outnumbered them ten to one. If rescue was to be attempted there was not an instant to lose. The five cavalrymen were sent off at a gallop. Seeing them,

the men in the ambulance jumped out and ran through the Indians toward them, rightly conjecturing that the Indians would secure the ambulance before turning to attack them.

It was a plucky thing to do, but the doctor determined that it was their only chance. The Indians caught the mules, then turned to look for scalps, which they supposed were to be had for the taking. The doctor and his men were giving them a lively fight when we came up. The value of a well-sighted and balanced rifle was soon evident. With every crack a pony or an Indian came to earth. This fire was evidently unendurable, and the circle quickly



MURDERED AND SCALPED.

drew. The scalp was gone, and a few arrows that still remained in the ribs marked the tribe to which the victim belonged—Cheyenne and Apache.

The buffalo were more numerous than usual: two fine ones were brought down. An antelope, too, formed a portion of our larder that evening. The meat of the antelope is as tender as venison tenderloin. There is a strange difference between the coat of the antelope and that of the deer. It is difficult to describe the substance of which the coat of the antelope is composed. It does not seem to be hair, but a curiously brittle imitation that has the appearance of a vegetable fibre. Catch hold of it, and



ATTACK ON THE AMBULANCE.

increased in diameter, when, with the rescued men mounted behind, we slowly moved toward the station, before reaching which two more dashes were repulsed.

The strain on the nervous system of the rescued men must have been intense. As we reached the station one of them broke down completely and sobbed like a child. The doctor was one of the gamest of little men. "Ah!" quoth he, as he gazed through the glass at the crowd of Indians about the ambulance, "I put the contents of the tartar emetic can into the flour before I left the ambulance, and if that does not disorder their stomachs I won't say any thing—I wish that it had been strychnine!"

A redskin had mounted each of the mules, and as many Indians as the vehicle would contain had located themselves in the ambulance for a ride. The cover had been torn off, as it probably impeded their view. Becoming tired of this they detached the mules, unloaded the ambulance, and drew it to a point which afforded us the best view of their performance; when, greatly to the indignation of the doctor, they crowned their disrespect for him and his carriage by setting fire to what he declared to be the best ambulance on the plains.

The Indians now engaged in a successful dance about the burning ambulance, during the continuance of which a survey was made of our situation.

The station had been furnished with a garrison of ten soldiers. Five of these, with the best arms and most of the ammunition, had started early in the morning on a buffalo hunt. We had altogether twenty-one men, armed with seven rifles and thirteen revolvers. For four of the rifles and five of the revolvers we had an abundance of ammunition, which it was not possible to use in the other arms, for which there was but a scant supply. The adobe was well located for defense, and surrounded by a well-constructed rifle-pit. To attack the Indians was not prudent, although all were anx-

ious to do so. We could count in the circle about us one hundred and five, many more being visible on the bluffs near.

A new style of fighting was now inaugurated by the Indians. The bluff in which the adobe was located was covered with tall dry grass. This was in flames before we were aware of a fire other than that about the ambulance. Each man seized his blanket and started out to meet the fire, which was nearly subdued, when a sudden attack was made by the Indians on all sides. For a few moments it was a doubtful contest. The Indians were at last driven back and the fire extinguished. Several of our men were suffering with arrow wounds, none of them severe, fortunately; but all needed attention. If poisoned arrows had been used our loss would have been serious.

The arrows used were about three feet in length, and supplied with an iron head two inches long. Poisoned arrows are made very differently from the arrow ordinarily used. A rattlesnake is caught and pinned. He is made angry by being poked with sticks, when a piece of deer liver is held toward him on the end of a stick. Into this he strikes his fangs. The liver is then withdrawn, and a piece of dog-wood about four inches long, carefully sharpened, is thrust into the incision made by the fangs. The stick is permitted to dry for a short time, when it is dipped into a glutinous solution, which, drying, hermetically seals the poison, which would otherwise decompose. This piece of dog-wood is used as the head of the arrow. To be wounded with such an arrow is almost certain death.

The buffalo, or hunting arrow, is made differently from the war arrow. The notch in which the string of the bow fits is cut differently, and the head of the arrow is fastened on much more firmly. The Indian desires that the head of the war arrow shall detach itself from the staff as soon as it enters the body of an enemy. It is not a rare thing to meet on

the plains men who have heads of Indian arrows buried in their bodies, the wound having healed.

At nightfall the Indians withdrew. But this was not a subject for congratulation, for we expected them back during the night. The anticipation was not erroneous. Three hours of darkness had passed, when a rustling whiz cut the air over our heads. The sharp twang of the bow-string informed us that the Indians were very near. Arrows came in flights. The Indians were within close revolver range; but a shot from a pistol or rifle would have exposed the person firing, as the flash would reveal his precise location. So many arrows could not be fired among our small party without inflicting serious damage.

That something must be done to drive off the Indians was plain. One of the party, an old hunter, volunteered to stampede the Indians if he might be permitted to take four revolvers. If he failed, the revolvers would be lost, which loss would severely cripple the party. Still, it was the last resort. Divesting himself of garments, with the exception of under-clothing, he crawled out into the darkness toward the spot from which the twang of bow-strings came the most frequently. In five minutes the repeated crack of his revolvers and the yells of the Indians told of the successful issue of the bold effort. The bows were still, and in another moment our Indian fighter returned to the adobe to receive the heart-felt thanks of the garrison.

The remainder of the night was passed in quiet. Sleep was impossible, and dawn found the party on the alert for another attack. Mid-day and dawn are the favorite times of Indians for an attack. It was well for us that we were ready; for the Indians had crawled up as closely as possible, evidently intending to rush upon us if there seemed any chance for success. A single rifle-shot seemed to satisfy them, as they withdrew in haste, with the exception of one. His scalp locks were "saved."

Toward noon a body of men were seen approaching from the east. If they were Indians we were "gone." If white men, the danger might be said to be over. The Indians observed them as quickly as we, and a band of twenty or thirty started off to reconnoitre. We watched the result anxiously, riding up toward the new-comers. The Indians wheeled about and returned to our vicinity. A moment more and the whole band were galloping off out of sight over the bluffs. Then we knew that the strangers were white men. They were a company of infantry in wagons, who, together with a small cavalry command, were coming to bury us. The Monuments had been attacked the day previous, and a number of stock driven off. We afterward learned that a general attack had been made along the entire line of two hundred and fifty miles. The stage company lost eight men and nearly two hundred mules; the Government lost several men and a hundred animals; the Indians committing the outrage being at the time on the way to Fort Zarah to secure the presents stipulated for in the late treaty.

We had come to the discovery that it was not "Lo, the poor Indian!" but Lo, the poor white! Cooper might have his Indians; we did not care for their company. It is useless

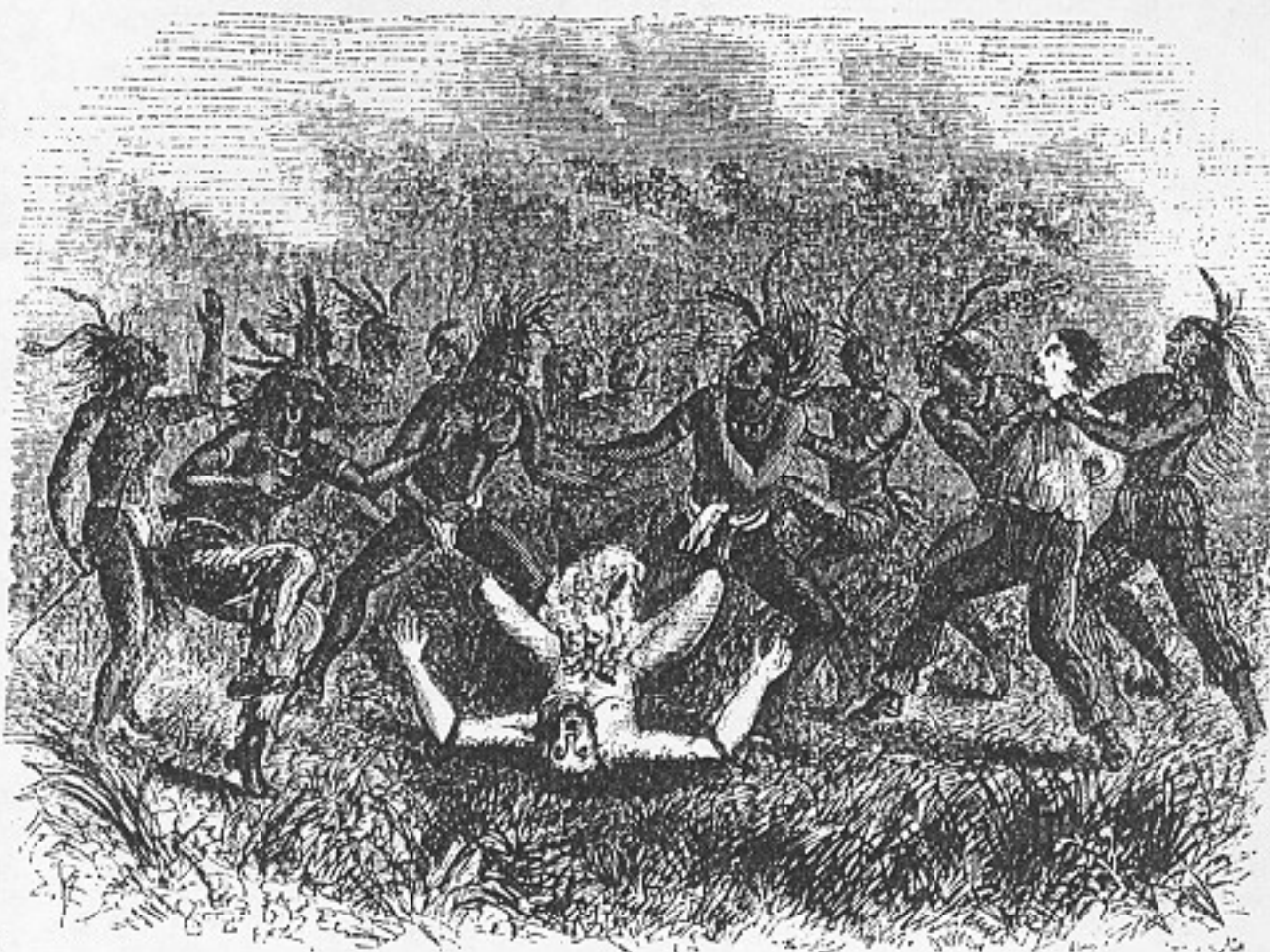
to make treaties with the Indians, put them on a "Reservation," build them comfortable houses, and endeavor to make them comfortable. It is perfectly useless, as they regard this as an evidence that the white man is afraid of them. They are right. He most undoubtedly is, and will suffer loss of property and bodily injury to avoid any conflict.

It is, to be sure, a hard thing to say, but there is safety in extermination alone, and this can be effected only during the early spring, when the Indians are in their villages. The grass is then too scanty to keep their ponies up for use on the war-path. At this time the Indian is friendly. Grass comes again; he has fooled the white man, and is again on the war-path. Each year more white men lose their lives on these plains than Indians. The Platte route is marked by a line of graves nearly three hundred miles long. The Arkansas is as bad, and the Smoky is fast becoming lined with the graves of a race of hardy pioneers that we can ill afford to lose.

We left the adobe at Smoky Hill Spring, and proceeded with a strong escort, and camped at night at Henshaw Springs, which we found deserted. The following evening we arrived at Pond Creek. During the day a great number of dog villages were passed, the little villagers squeaking out a salute as we passed.

Pond Creek is the most picturesque station on the route. The creek comes out of the plains near a fine cotton-wood grove, runs with a considerable current for five or six miles, and sinks into the plains.

Among the branches of the cotton-wood trees are swung the remains of Indians encased in a basket-work of twigs. An engineer party is



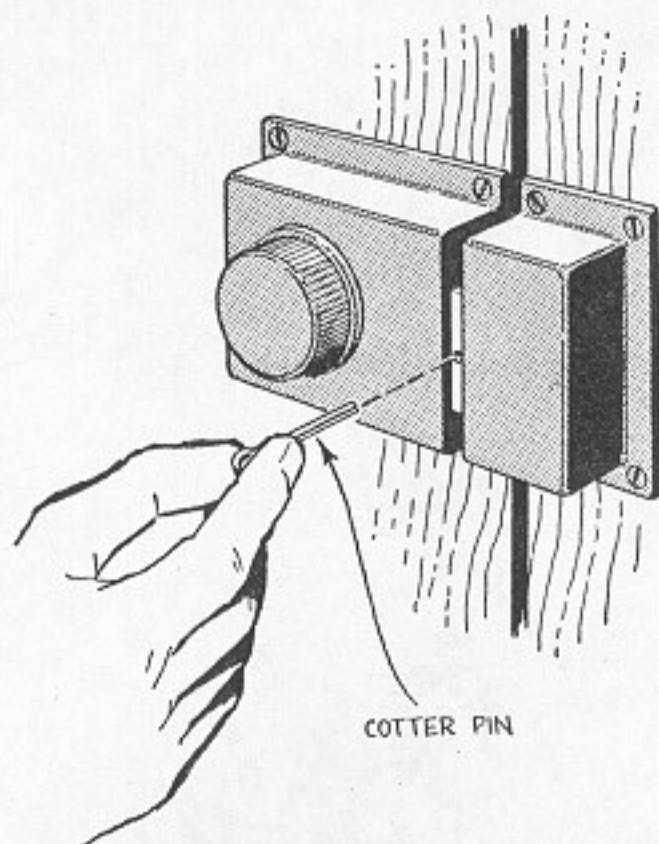
LO, THE POOR INDIAN!

here purposing to start for Fort Lyon over a new route. The distance is thought to be seventy miles over a country destitute of water. Wood and water are the great necessities of the plains. Over dry stretches it is frequently necessary to transport water for a considerable distance, and fire-wood is frequently hauled to a post a distance of seventy-five or eighty miles.

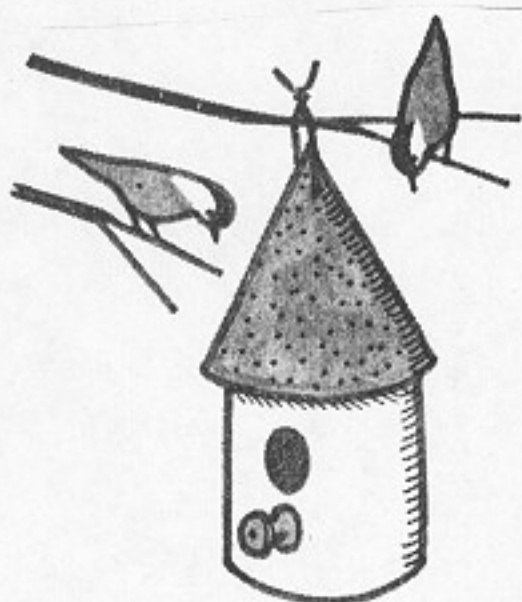
The soil can not be cultivated unless it is located convenient to water with which to irrigate it.

From Pond Creek the stage line had not been disturbed, and we traveled uninterruptedly to Denver, which place we reached on the 2d of December, after a trip of fifteen days across the plains from the Missouri River to the base of the Rocky Mountains.

Lock for a Lock



- Some door locks of the type shown have no positive system for being locked in shut position. Provide one by placing the slide in closed position and drilling a tiny hole in the exposed portion. Insert a small cotter pin in the hole to prevent the slide from moving.



PLASTIC BOTTLE BIRD HOUSE

Remove the label from an empty plastic bleach bottle and—about halfway between top and bottom—trace around a 50-cent piece to mark out a bird door. Punch along the line with an ice pick or other sharp object, and push out the circle of plastic. A hole this size will accommodate wrens, nuthatches, and chickadees. Run a bolt through an empty spool, and fasten it to the bottle just below the door. (You can reach through with finger and thumb and screw on a securing nut.) Make a cone roof from a piece of bright linoleum. Punch two holes in the roof, and two near the top of the bottle, and run a piece of wire through them. The wire holds the roof to the bottle and provides a loop to slip over a branch.—B. S., Paradise, Calif.

Rolled Towels Save Space

- Save room in your linen closet by rolling towels instead of folding, for firmer packing. Towels will be rotated in use if you put fresh rolls on top and take from the bottom, allowing the fresher towels to drop down into the empty spaces.

"BABY PRINTS" IN PLASTER ARE LIFETIME KEEPSAKES

By Ralph T. Moore

Popular Mechanics November 1955
IF YOU, like many parents, want to keep lasting mementos of your youngster's babyhood, preserve your baby's hand and foot prints on these unique wall plaques. Common puttylike products, such as calking compound, ordinary putty or child's modeling clay, may be used to obtain the prints. Most any product that will retain an impression and also permit plaster of paris to set will do the job.

You will need about 1 lb. of putty. Roll this out on a piece of board or plywood to roughly 6 in. square. The surface of the putty should be smooth and flat. Then moisten the baby's hand or foot with water and press it gently but firmly into the putty. Don't rush this part of the procedure, but use a slow, steady pressure without trying to press too deeply into the putty. Remove the hand or foot slowly from the mold so the putty does not adhere to the skin. If the resulting print is not satisfactory, roll the putty smooth and make another impression.

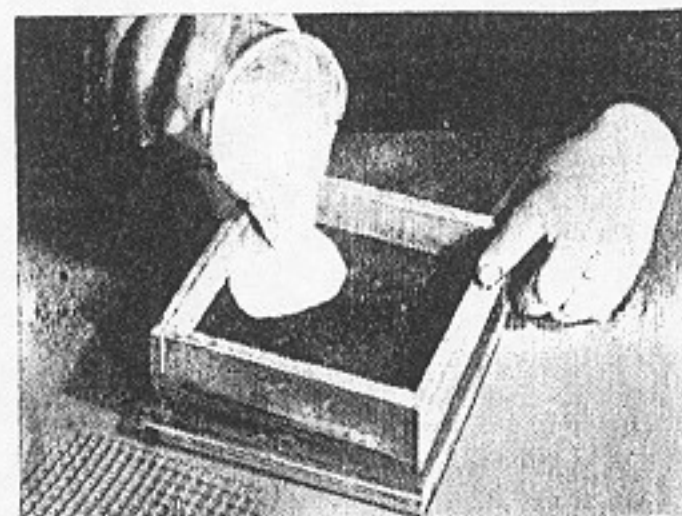
For the next step, make a square frame from four pieces of $\frac{1}{4}$ x $1\frac{1}{2}$ x 6-in. plywood. Force this down over the putty to form a dam around the print. Cut a piece of $\frac{1}{4}$ -in.-mesh hardware cloth 5 in. square and twist a loop of thin copper wire into the mesh about 1 in. from one corner. This becomes a sturdy loop with which the finished plaque may be hung.

Next mix plaster of paris with water, stirring until smooth, grease the surface of the mold so the casting will not stick to it and pour the plaster of paris into the mold. Press the hardware cloth completely into the plaster with the wire loop at the upper corner of the plaque. Then smooth out the plaster and allow it to set overnight.

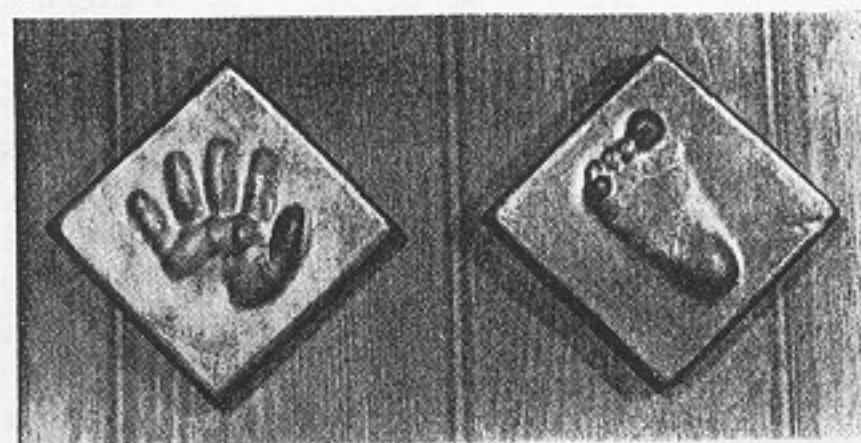
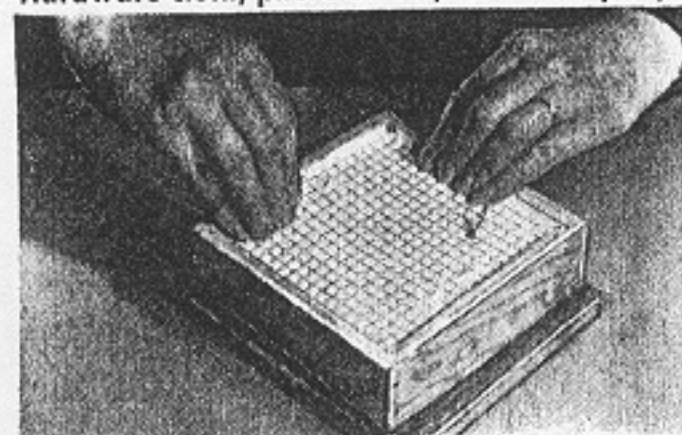
After the plaster has set, pull the frame apart and remove the casting from the mold. Permit it to cure for several days and sand and bevel all sharp edges. Seal the plaster with a coat of shellac which, when dry, may be followed with a colored-enamel or metallic finish. If you like, glue felt to the back of the plaque.



Hand or foot impression is made in putty which has been rolled smooth on a piece of plywood



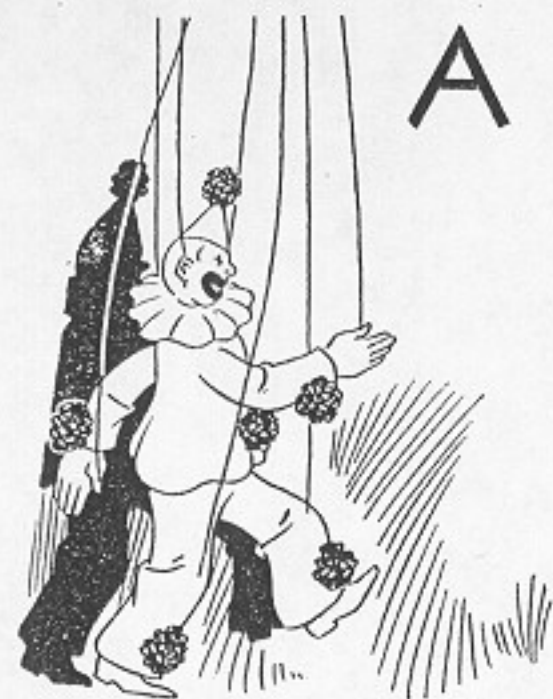
Plywood dam is set up around impression and plaster of paris is poured into mold, above. Hardware cloth, photo below, reinforces plaque



A Puppet Show for Your Home

POPULAR HOMECRAFT APRIL, 1936

MORRISE WAGNER



The string puppet is much more versatile than the hand puppet. He can walk, dance, leap and perform various merry pranks. To these very advantages he owes his greatest charm. We must always bear this in mind and make them supple and pliable.

Planning the Marionette

First, make a sketch of the body of the whole figure. Decide on the height of the marionette; about eighteen inches is a good height for a beginning. As in hand puppets, the head may be a little larger than in human proportion. The head of an eighteen inch figure should be three inches from chin to the top of the head. (Fig. 1) Make a drawing the exact size.

Last month I described the process of making a head for the hand puppets out of balsa and plastic wood. For the marionette the same type of head is very effective, and, due to the lightness of balsa, the head will not be too heavy. The difference between last month's process and the head of the marionette is in the making of the neck. It should be from $\frac{3}{4}$ " to 1". Shape the neck into a rounded inverted cone. (Fig. 2) In the base of this cone drill a $\frac{1}{2}$ " hole $\frac{3}{4}$ " deep. Place a little good glue in this hole and fill with plastic wood. Allow this to harden thoroly and then insert a screw eye with the hole facing the front of the head. (Fig. 2).

Making the Body

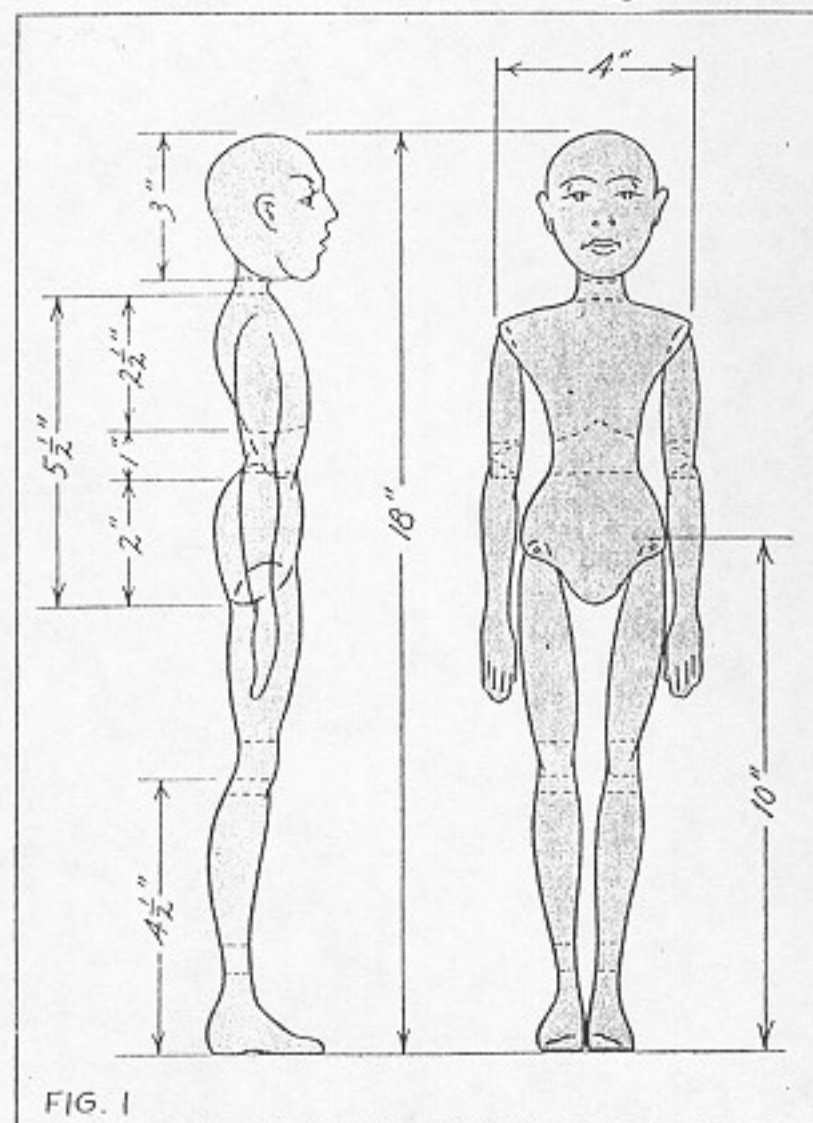
Plan a very simple marionette for

the first attempt. Learn the "feel" of a marionette; where weight is necessary; the flexibility of the joints; then you'll be able to give your own ingenuity full sway. The first figure will be made of cloth stuffed with cotton and sand.

Unbleached muslin is inexpensive and ideal for the body of the marionette. Study the pattern as shown in Fig. 3, then cut a paper pattern to the scale of the marionette. The tabs on neck, shoulders and hips are used for attaching head, arms and legs. These are important. Cut two pieces and sew, leaving the center portion, between a and b, unsewed. Turn and sew tabs, then stuff tightly with cotton batting

so that the upper and lower parts of the torso are firm. Stretch from a to a and b to b, as shown in Fig. 3.

The same process is followed for arms and legs (Figs. 4 and 5). Sew, turn, sew from a to b, then stuff firmly with sand rather than cotton. This will give the arms adequate weight for ease in manipulation. Sew at ends, leaving tabs at either end, as shown in diagram. The hand is made in the same manner as those for the hand puppets, using the wire frame and then modeling with plastic wood. While the plastic wood is still



soft, punch a hole thru the thumbs (Fig. 6). There is no need for a wrist on the marionette's hand. In making the wire frame, make a loop at the base of the hand. This will be used to attach the hand to the lower arm. Gather the tabs at the base of the lower arm. Paint the hands, and when dry sew the ring at the base of the hand securely to the tab. Sew so that the hand hangs with the palms facing the back of the arm. The arms are now ready to be attached to the tabs at the shoulders. Gather the tabs together at the top of the arm and be

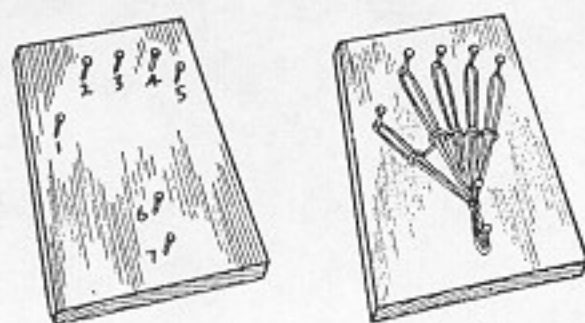


Fig. 5. Construction of Hand.

certain that the arms hang close to the body and the thumbs are on the inside.

At Fig. 7 is a pattern for the legs. Sew, stuff and gather tabs at base and top. For extra weight, which will be needed for proper manipulation, fill the legs, also, with sand instead of cotton. The feet may be carved from wood or modeled with plastic wood (Fig. 8). Insert a screw eye at top. Sew a screw eye securely to the base of the leg. Be sure that the feet rest firmly on the floor and that the joint at the ankle is flexible. Now sew the legs to the tabs at the hips. Sew so that the legs hang toward the center and the ankles almost touch. Next, sew the head to the tab at the neck. The marionette is ready to dress and string.

As we have done previously, for the sake of illustration, we shall make a clown. This figure will be very useful and is excellent as a first one. He will do tricks and act as Master of Ceremonies.

A clown is usually dressed in white. Use a soft material such as sateen. Fig. 9 gives a pattern for the costume, consisting of coat and trousers and pointed hat. Use cardboard to stiffen the hat. Make pom-poms of red wool and sew them as shown in Fig. 10.

Stringing and Controls

The next job is to string the figure so he may go into action. Strings are attached to the most important parts of the figure: at the knees, the hands, the back at the shoulder blades, and either side of the head at the back of the ears.

Use a thin fishing line for strings. This is strong and knots less readily than ordinary string. Before you put the costume on the marionette, sew three-foot lengths of the fishing line to the knees and in the center of the back, just in the middle of the top

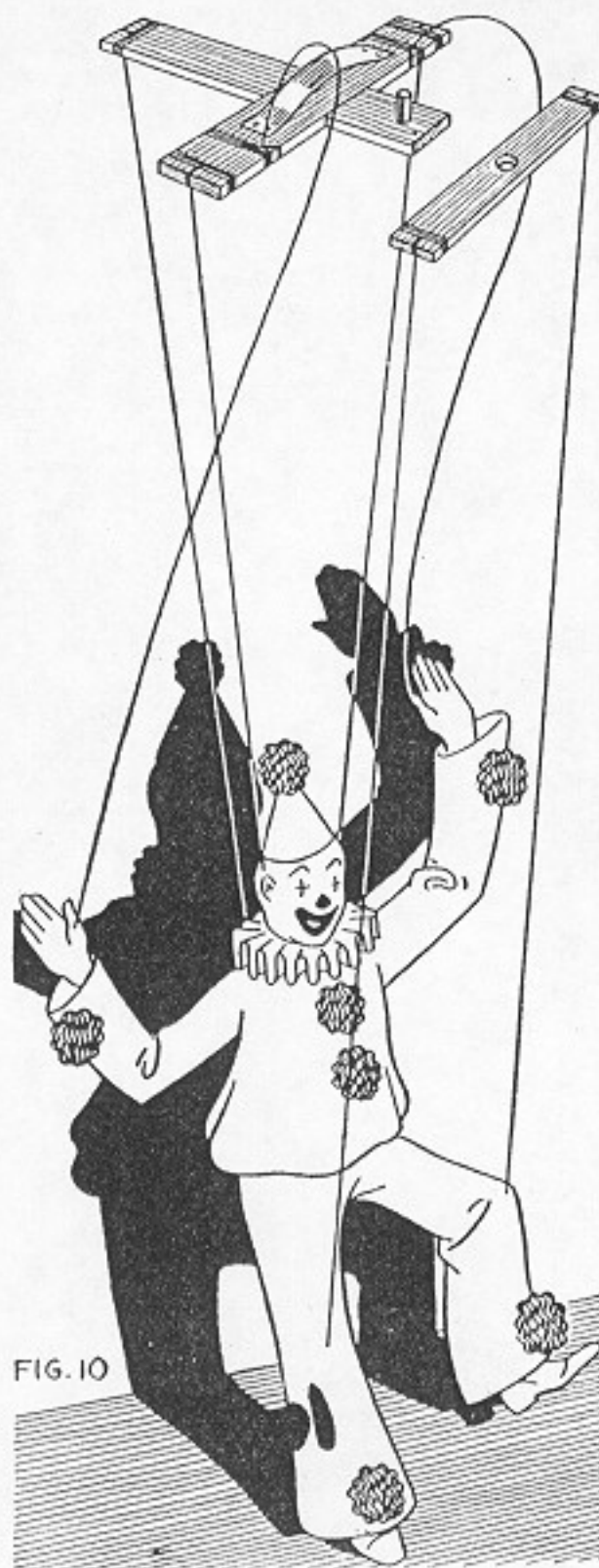
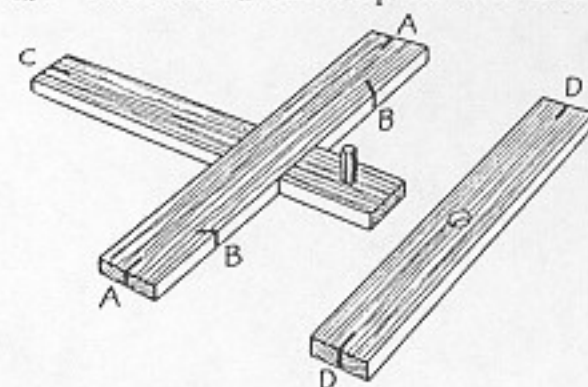


FIG. 10

part of the torso. Now thread these thru the costume and sew the costume on securely. Put a ruff around the neck of the figure. Next thread three-foot length of line thru the holes in the thumbs; tie securely. Before fastening the strings to the head, we should make the "control." This is the term used for the contrivance which really controls the movements of the marionettes. It is made of wood in two parts. The first part, in the shape of a cross, controls back, head and arms; the second is a cross bar which controls the legs (Fig. 11). Now drill a small hole just above each ear, fill with plastic wood, insert small screw eyes and attach two-foot strings to them. Make saw cuts in the controls as shown in Fig. 11. Place the leg

control on the peg by means of a hole drilled in the center. Be sure it fits the peg loosely so that it may be removed easily.

Hold the controls in a horizontal position and attach head strings to points "a". Insert string in saw slits, knot end and wind several times around the control. Be sure that the head is straight. Now lower the puppet until the feet just *touch* the floor—not actually rest thereon. Now attach the other cords, as shown in the diagram. Be sure the back and head strings are taut. Let the arms hang limply at the sides of the figure. Adjust the leg strings so that the legs are perfectly straight when the cross bar is attached to its peg. Now that the puppet is strung, there only remains one last touch. Fasten a leather thong to the main control at points "E". Your hand can slip in this and



A = HEAD STRINGS
B = HAND STRINGS
C = BACK STRING
D = LEG STRINGS

FIG. 11

your fingers are free to work the string and are not needed to manipulate the control. The marionette is now complete.

Operating the Marionette

The first, and perhaps the hardest, thing to learn in working the marionette is the simple art of standing erect. Learn the "feel" of the marionette when it is standing with feet flat on the ground and the *knees perfectly straight*. Beware of the sagging marionette.

The marionette is now ready to take his first step. Slip the left hand in the leather thong of the main control and hold it horizontally. Now with the right hand remove the foot control from its peg.

If possible, hold the first rehearsal before a mirror. Then you may glance

over and see just how the marionette responds to the movements of the controls. Walking requires the movement of both controls. Tilt the front piece first up and then down, and with the other hand move the main control forward, turning it from side to side. Practice these two movements until the marionette walks easily and you are no longer conscious of the controls in your hands.

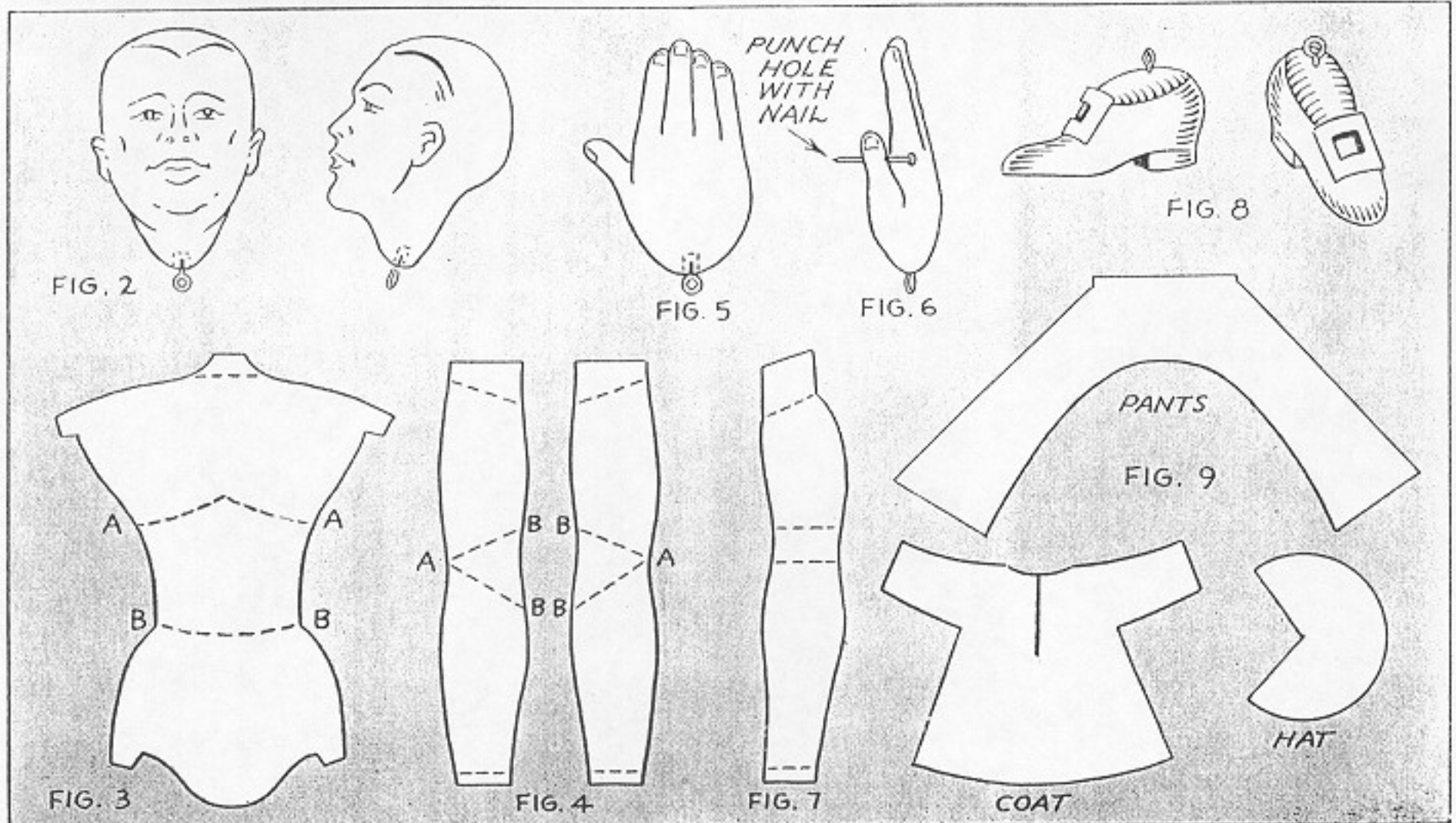
If you are practicing before a mirror, don't allow yourself to get into

the habit of looking continually into it. Watch the figure as it walks on the floor. If you tip the main control forward, the figure will bend its head. If you tilt the controls from side to side while in this position, the marionette will shake its head. To make it bow, tilt the main control forward so that the figure is practically hanging from the back string. The marionette can dance, point, sit down, weep, say "yes" and "no," and do anything you can do and more. Let

each movement be clear and rather exaggerated.

If you feel that the puppet needs more weight at the hands or feet, fasten shot or a small lead weight at the wrists or on the soles of the feet.

One thing more, when you put the marionette away, tie a piece of cord around all the strings, and, after replacing the foot control to its peg, hang the control on a hook.



Homemade liverwurst spread and crisp salty crackers make a delicious appetizer

You may be surprised to learn how easy it is to make your own homemade liverwurst spread. You start by cooking pork shoulder and pork or baby beef liver; then

Make your own SUNSET liverwurst

OCTOBER 1967

grind the meats together, add seasonings, and chill at least a day to blend flavors. If you want, you can keep the spread in the refrigerator for several weeks. We packed ours in attractive ½-pint crocks for serving and storing. Add your own labels to give as gifts.

HOMEMADE LIVERWURST SPREAD

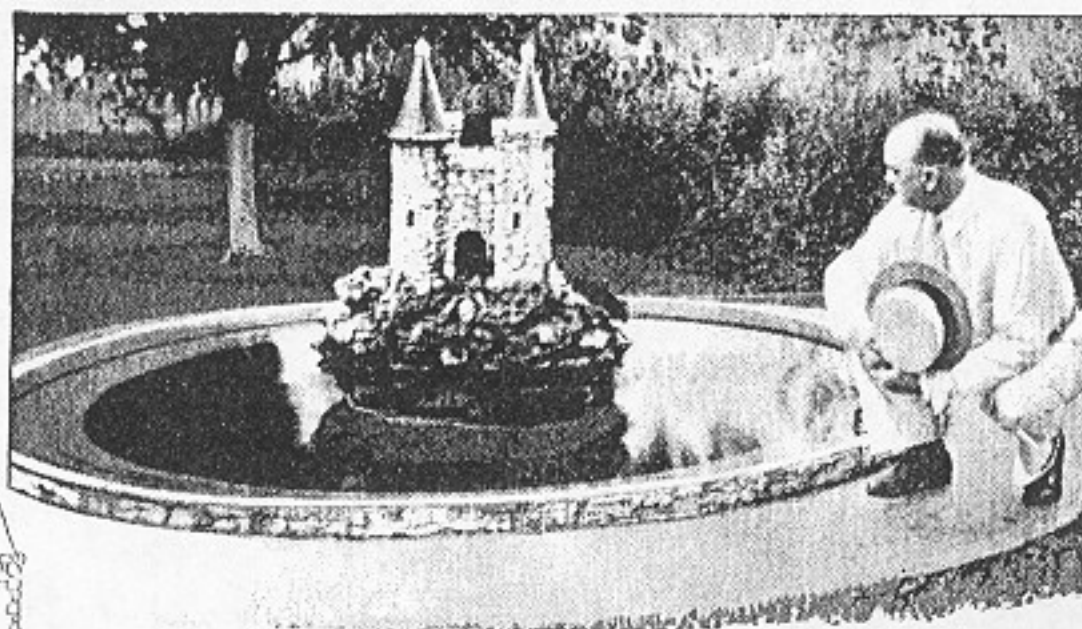
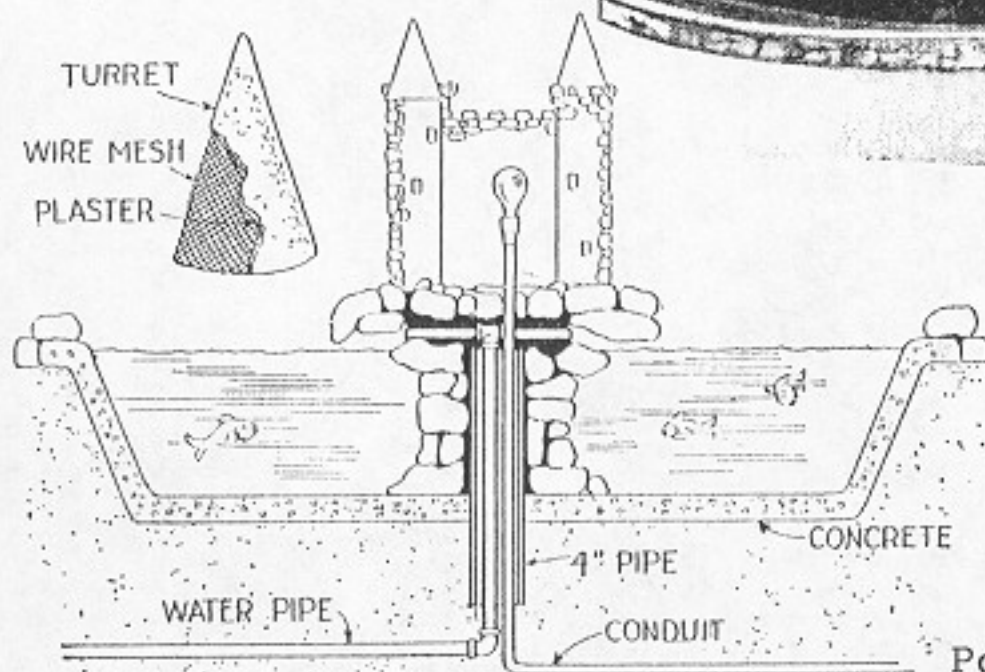
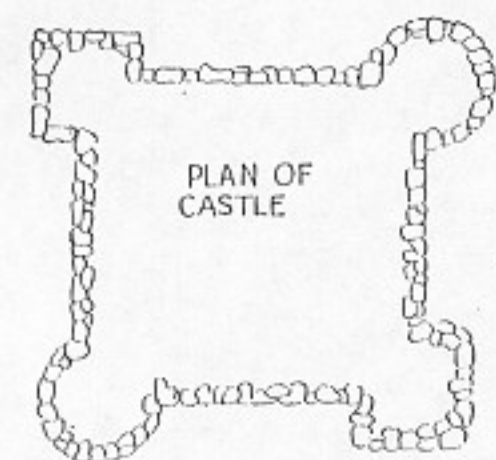
In a 3-quart pan place 1½ pounds of boned pork shoulder (with some fat). Add 3 cups water, 1 teaspoon salt, ½ teaspoon pepper, 1 teaspoon monosodium glutamate, 1 bay leaf, 1 whole clove of garlic, 1 medium-sized onion, quartered, 6 stems parsley, 2 stalks celery, and ½ cup dry white wine (optional). Bring to boiling, cover, and simmer 1½ hours, or until

tender. Remove meat; cool; cover and chill well. Save 1 cup strained broth.

Place 1 pound pork liver or baby beef liver in a 2-quart pan. Add 2 cups water (enough to cover), ½ teaspoon pepper, 1 teaspoon salt, 1 whole small clove of garlic, and ¼ cup dry white wine. Bring to a boil, cover, and simmer 25 minutes, or until tender. Remove liver and cool; cover and chill well. Discard the broth.

Cut chilled meats into strips to fit food chopper. Using a fine blade, grind meat strips together; grind in 1 small onion. Heat the reserved 1 cup broth and measure out ½ cup; to it add ½ teaspoon each salt and pepper, 1½ teaspoons each onion powder and seasoned salt. Blend seasoned broth and ½ cup soft butter into meat; mix thoroughly. Add ¼ to ½ cup remaining broth to make a smooth paste. Taste; add salt, if needed. Cover and chill. Makes 4 cups.

Decorative Feudal Castle for Your Fish Pool



Resting in the center of your fish pool, this model gives a realistic impression of the old-time castle surrounded by its protective moat. Stones and mortar are used throughout, the four towers being capped with turrets of wire mesh covered with plaster. Electric lighting is optional and can be installed as indicated, if desired

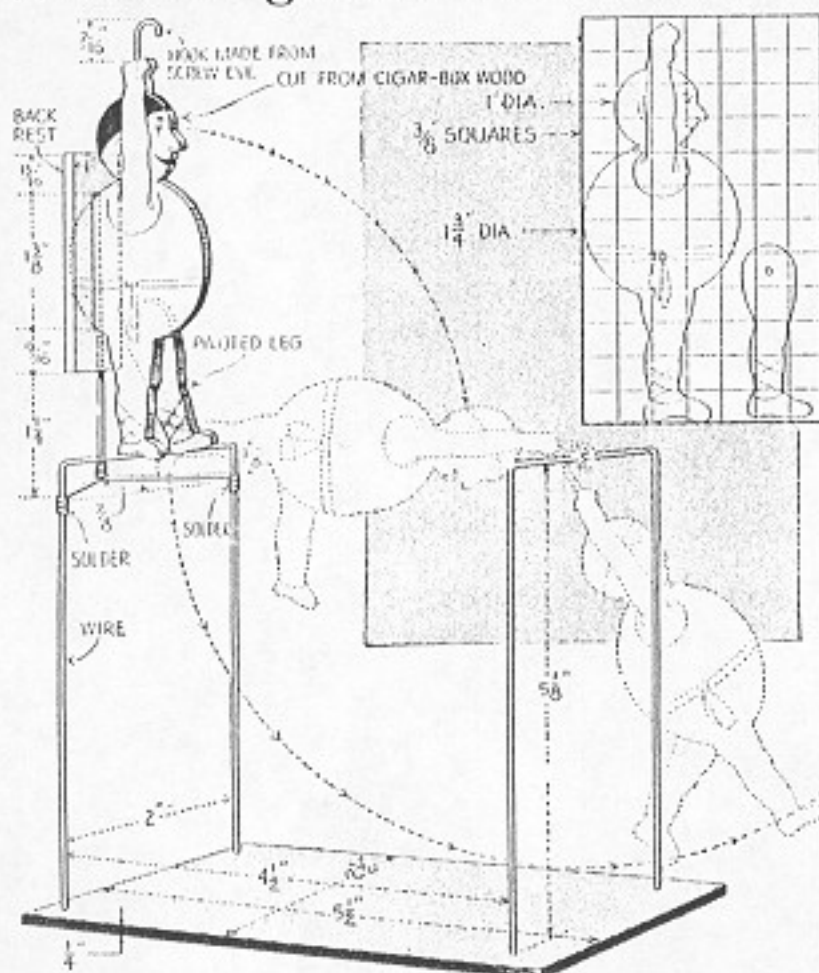
Popular Mechanics June 1938

This Tumbling-Acrobat Toy Will Delight Small Children

Here's a simple toy that will give the children a lot of fun. When the acrobat is knocked over, it appears to be falling to the floor. But just at the crucial moment, it hooks onto the next bar and swings with ease. A slotted back rest keeps the acrobat in position for the next act. The figure is cut out of cigar-box wood with the arm and the right leg in one piece. The left leg is cut separately and swings on a pivot to give movement. A couple of pencil lines will establish identity of the arms and both sides.

Diluting Showcard Colors

The trick in using showcard color is correct dilution. For a really good job on large surfaces apply a second coat after the first has dried thoroughly. Beginners usually fail to allow for the fact that the color dries out quite a bit lighter. Frequently a drop of glycerin will improve the color work.

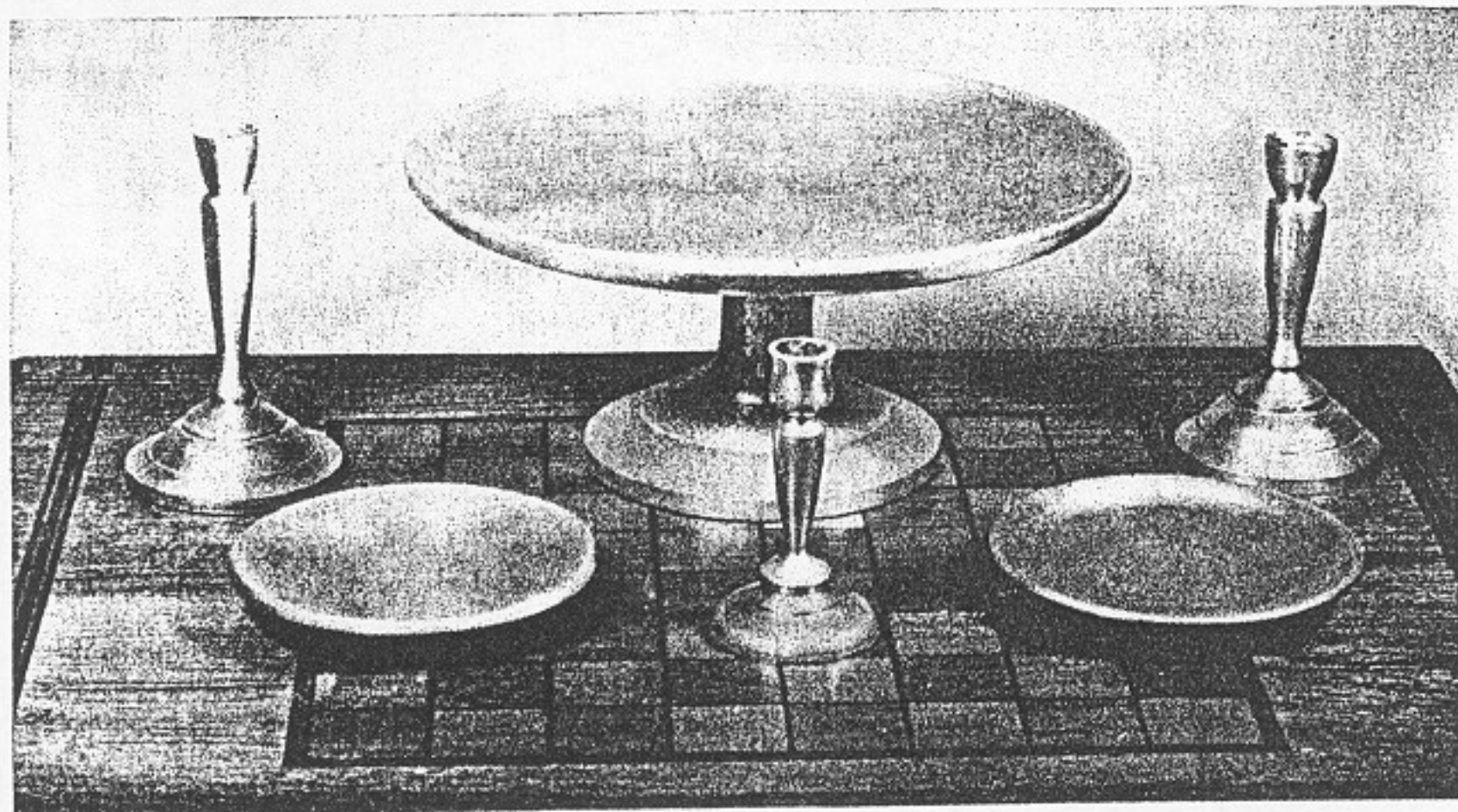


Dropping from a vertical position on one bar, the acrobat grabs the second bar as he falls and swings safely in a realistic manner

Castings TURN UP A NEW CRAFT

By R. H. Jenkins

THE HOME CRAFTSMAN JULY-AUGUST, 1939



A new adventure in a fascinating craft challenges the workshop owner who is willing to learn the process of re-casting scrap aluminum for lathe-turning such handsome objects as fruit plates, candlesticks and others

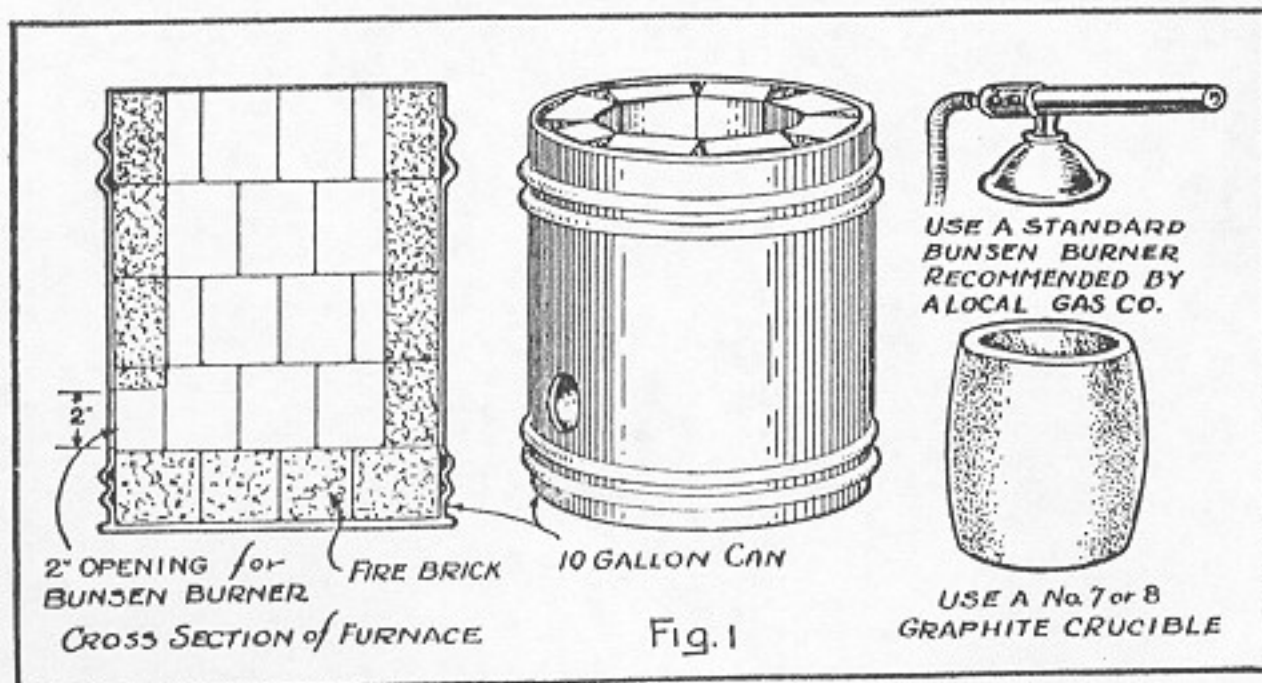
THE WIDESPREAD use of aluminum alloys in the manufacture of automobile parts has opened an opportunity of interest to the home craftsman. The metal is cheap and easily obtained. It is a metal which can be melted readily with ordinary gas heat. In molten state it can be cast easily into shapes which can be turned on a wood lathe without difficulty. Ash trays, cake plates, candlesticks, bon bon dishes, pancake griddles, lamp bases and cooking utensils can be made from re-cast aluminum.

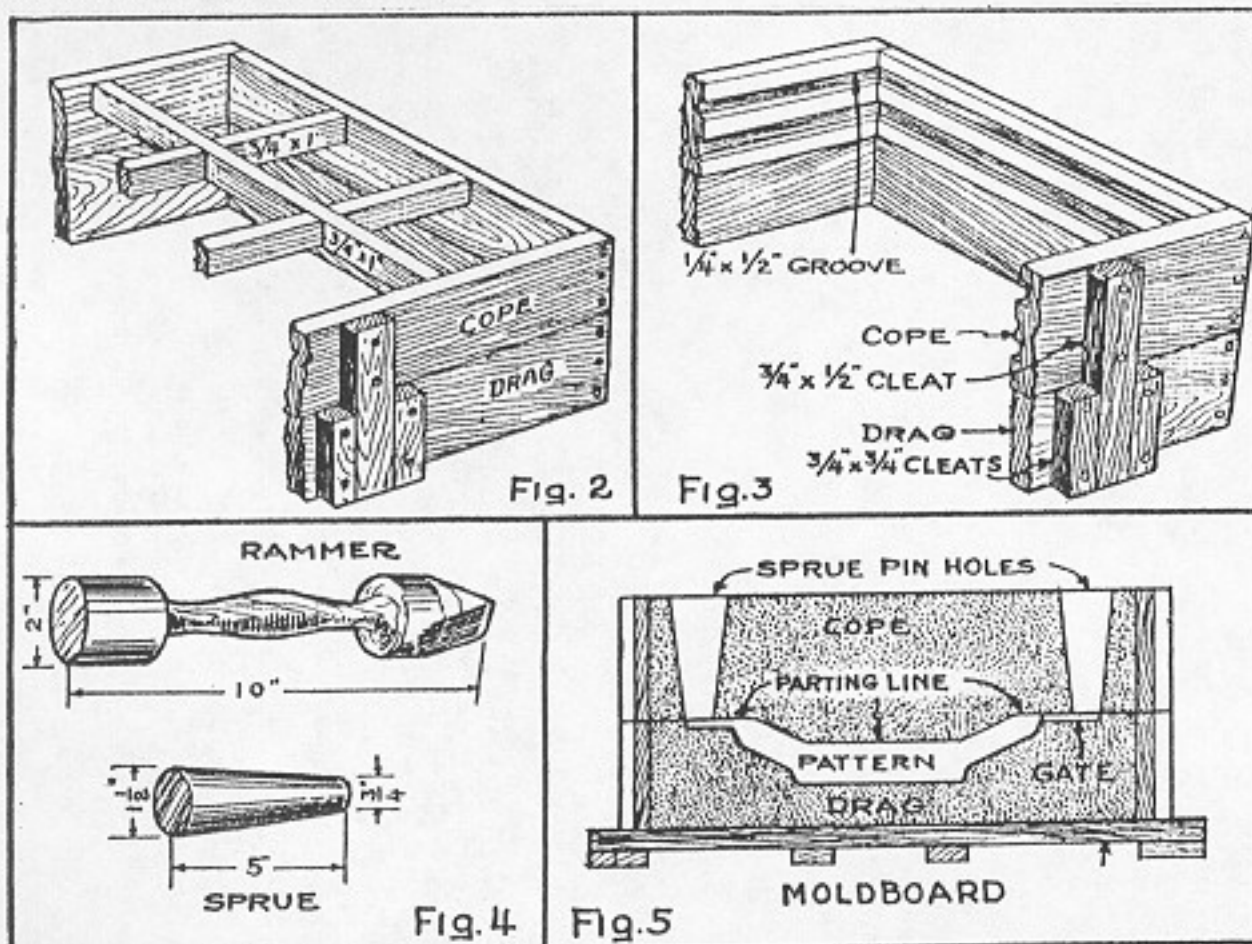
Most of the equipment needed is home-made and the rest of it can be purchased at small cost. A gas furnace is made from a ten-gallon can lined with fire clay and pieces of brick. A Bunsen burner is bought through the advice of the local gas company. A No. 7 or 8 graphite crucible must be acquired. Casting sand can be purchased for a small sum at any foundry, or could be dug from the sandy, sedimentary overflow along a river. Items which can be made include a bin for holding the sand, flasks for casting, sprue and riser

pins, rammer and other small equipment. Small flasks will not need the cope partitioned but the larger ones will. A wood lathe, because it affords the necessary flexibility in the use of the tools, is required for the turning of the cast metal. The turning tools can be made from worn out files. Glasses should be worn to protect the eyes against chips.

The first step in construction of the furnace is to cut a hole 2" in diameter

in the side of a ten gallon can. The bottom of the hole should be about 2" above the bottom of the can. This is the opening through which the Bunsen burner passes. As shown in Fig. 1 the can is lined with fire brick, cemented together with fire clay. It will be necessary to break the fire bricks into halves to fit them into the bottom. When the bottom has been lined with the bricks, the seams are filled with fire clay. The inside wall





of the can is covered in the same manner with the bricks, and all spaces are filled with fire clay. The furnace should be allowed to stand until the fire clay has been given time to dry. If heat is applied while the clay is still wet or damp, it will shrink and fall out of the joints. The first firing will probably require more heat than later firings. Bricks should be laid over the top to keep heat in the furnace when metal is being melted. Furthermore furnace should be set up on fire brick to prevent any of the bench top from scorching or burning from the heat that may be transmitted through the lining. Fig. 1 also shows a crucible which is to set inside the fire brick lining and contain aluminum parts that are to be melted. A heavy type of Bunsen burner completes the furnace.

THE FLASK HOLDS SAND

The flask for holding casting sand consists of two frames made of $\frac{3}{4}$ " stock. Each of these frames, for the work shown and described in this article, need be no longer than 14" square and 4" deep. The frames should be built and assembled in such a manner as to make them solid. Butt joints glued and fastened with 2" No. 9 flat head screws should be sufficient. Some provisions must be made to hold the sand in the cope; that is, to prevent it from falling out when it is being handled. This may

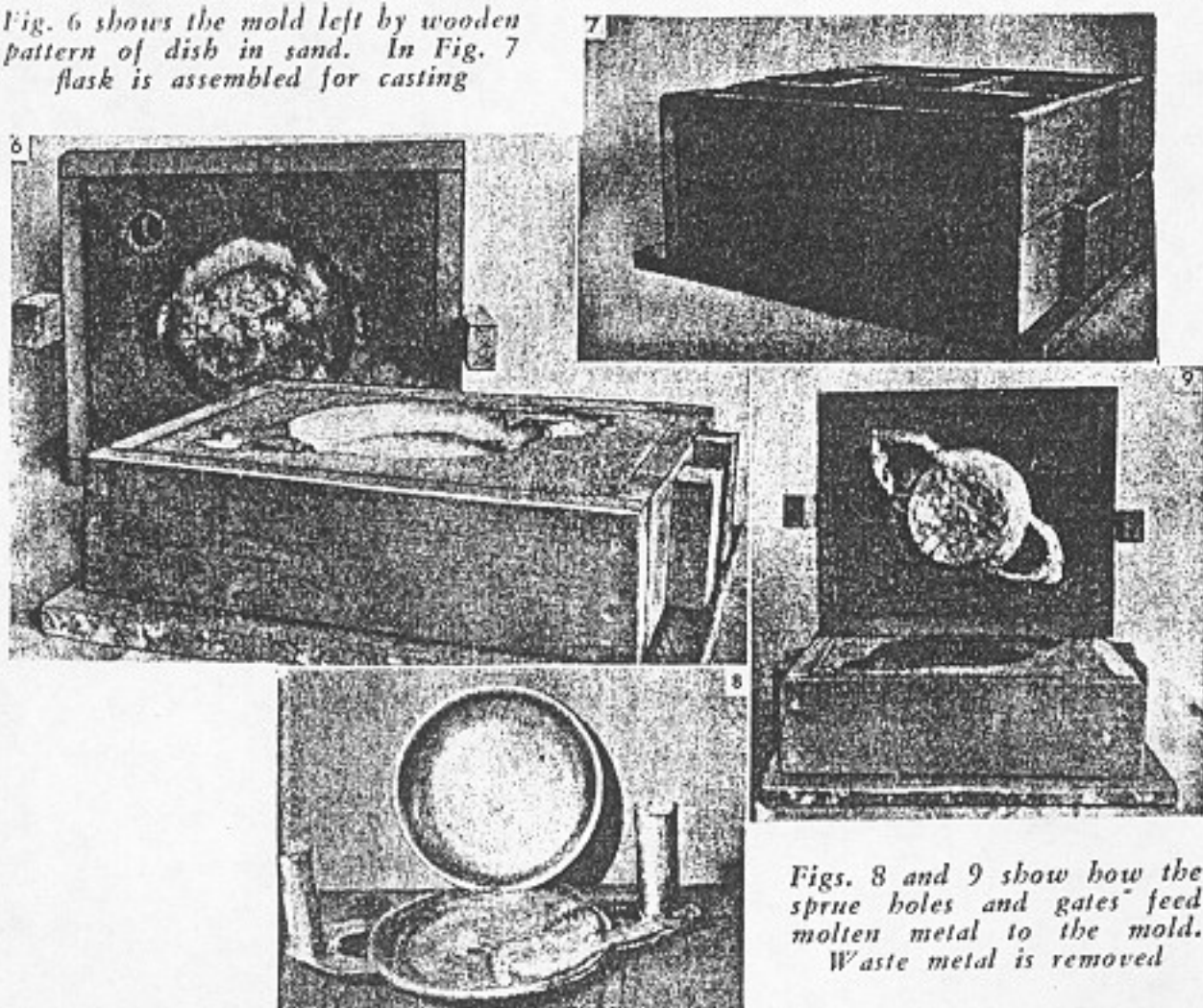
be accomplished in one of two ways, depending on the size of the flask. On the larger one, the cope may be partitioned as shown in Fig. 2, but on the smaller one, grooves cut on the inside face as shown in Fig. 3, will answer the same purpose. The cleats are nothing more than strips of wood, two of which are fastened to the ends of the drag with a $1\frac{1}{2}$ " space between them, while the other one is fastened to the cope in Fig. 6 shows the mold left by wooden pattern of dish in sand. In Fig. 7 flask is assembled for casting

order that the cope can be removed and replaced on the drag while the process of making the mold is carried on. These cleats eliminate danger of spoiling the mold and assure correct alignment of the two sections.

There are several other necessary items which may be considered as part of the flask equipment. Two molding boards are required as well as sprue pins and a rammer. The molding boards are nothing more than flat surfaces larger than the flask. They need not be any more than 2" longer and wider than the outside dimensions of the flask. Two pieces of $\frac{1}{2}$ " plywood braced with several battens on one side will answer the purpose. The rammer is made of hardwood turned and shaped as shown in Fig. 4. The sprue pins are made of any piece of stock. These pins are for the purpose of forming a hole through the sand in the cope leading down to the gate. When metal is poured through these holes it travels through the gate and into the mold.

WOOD PATTERNS COME NEXT

A one-piece ash tray pattern is the simplest object shown in the main photograph and is therefore the best on which to start the work as it casts easily and is not hard to turn. The sketch,



Figs. 8 and 9 show how the sprue holes and gates feed molten metal to the mold. Waste metal is removed

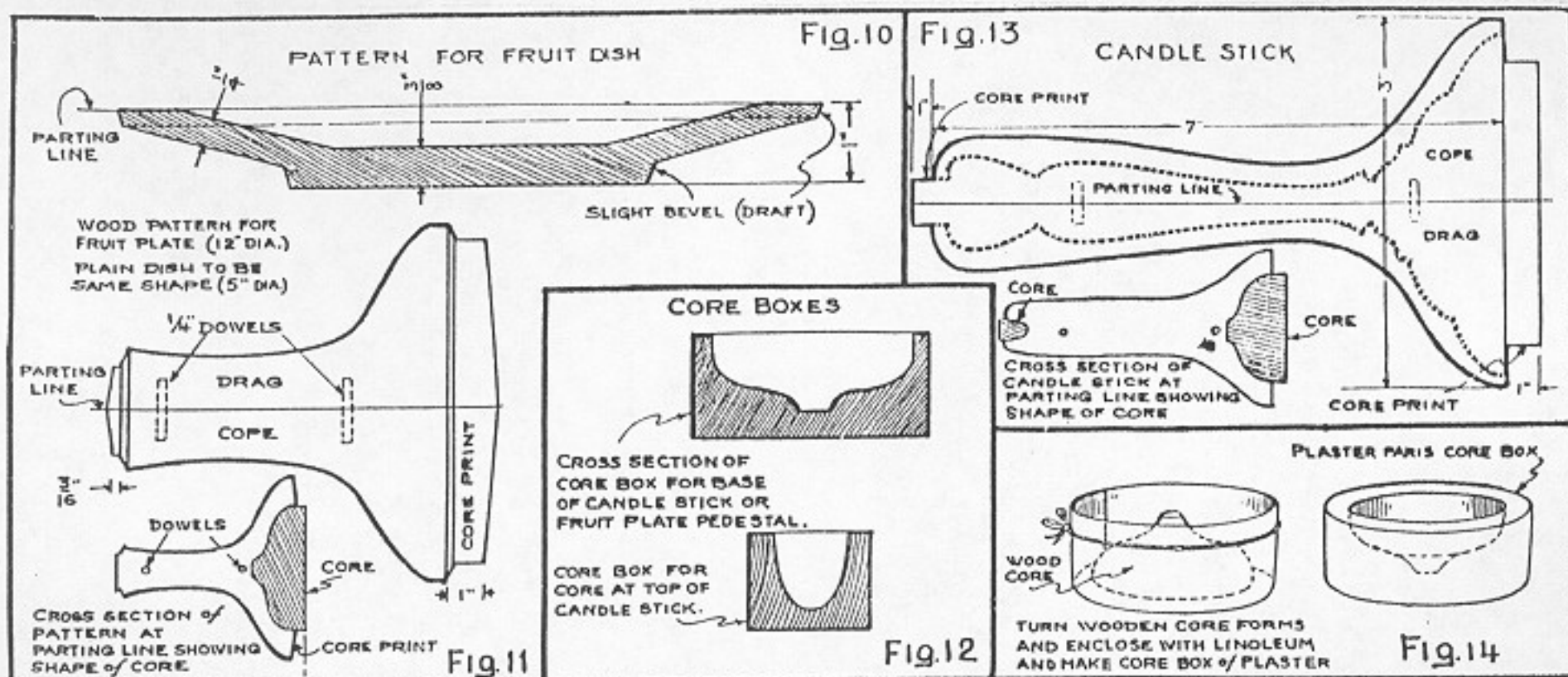


Fig. 10, shows a cross section of the tray pattern. This same pattern in larger size serves for the fruit dish. It is made of pattern pine which is a soft, straight-grained white pine. The diameter of the stock as well as its thickness will depend on the size of the dish or tray that is to be made. The sketch shows the thickness of the wood pattern after it has been turned on the lathe. It should be noted that none of the vertical sides of the pattern is at right angles to the parting line. These sides should be tapered a little as shown. In pattern-making this slant is known as draft and must be on every pattern in order that it may be removed from the sand without breaking the mold. The pattern should be finished smooth with sandpaper and coated with shellac. Allowance for shrinkage is unnecessary because the exact size of projects of this kind is not important.

Candlesticks are cast from patterns having two parts with cores for the top and base. Two pieces of stock $1\frac{1}{2} \times 3 \times 11$ will be required for the pattern. As this is a split pattern—that is, one in which half of it is in the cope and the other in the drag—the two pieces must be held together with dowels. Two short lengths of $\frac{1}{4}$ " dowel are sufficient. The holes for the dowels are bored in each half of the pattern but the dowels are glued into the cope half only. Rough stock 11" long is used to make finished pattern 9" long, including the two projections called core prints. This difference of 2" is to allow 1" at each

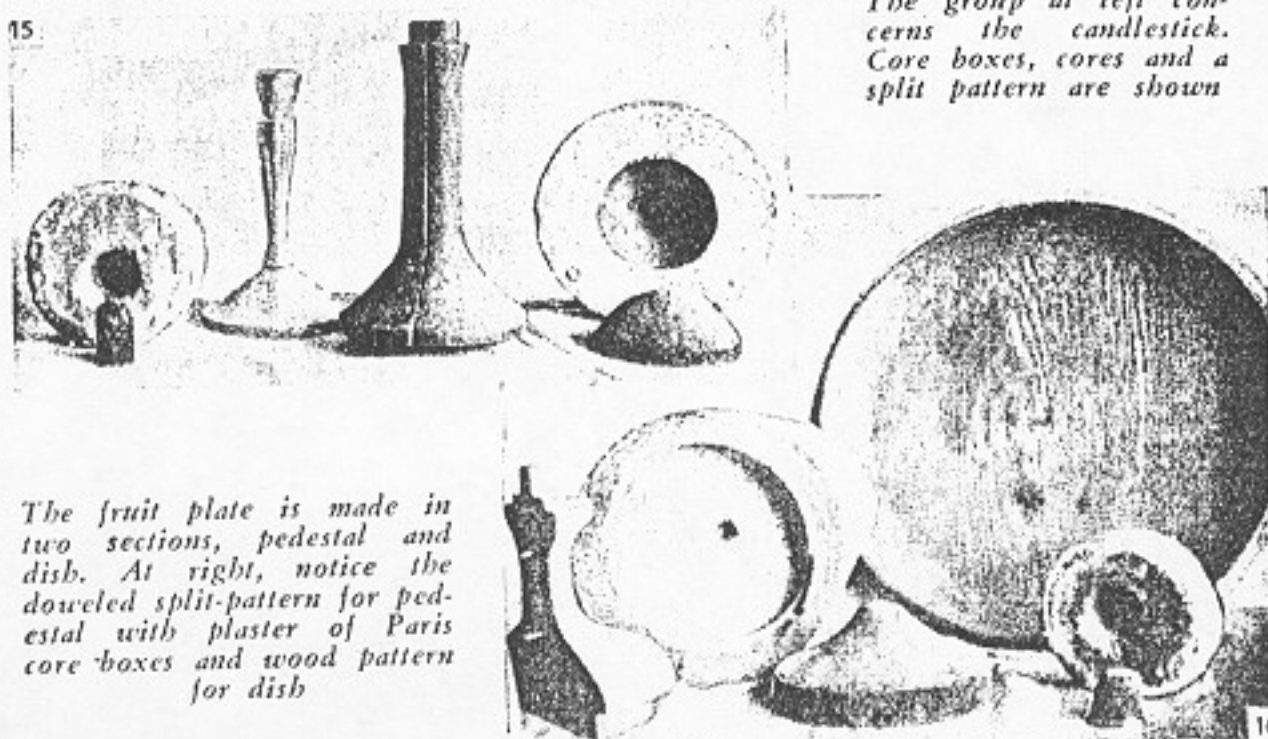
end to fasten the stock together while it is being turned in the lathe. The method of fastening the stock together is optional. A little glue spread on the inside faces over the extra 1" areas is one method. Another way is to drive a couple of corrugated fasteners into each end.

The pattern is turned to the general contour of the desired shape of the finished candlestick without regard for the small shoulders, coves or beads that will be required on the finished project. If it is kept in mind that all which is desired is a mass of metal from which the candlestick will later be turned, the work of making the pattern, mold and casting will be greatly simplified. The core prints left at the ends of the pattern should be about 1" long, their diameter more or less optional. Once

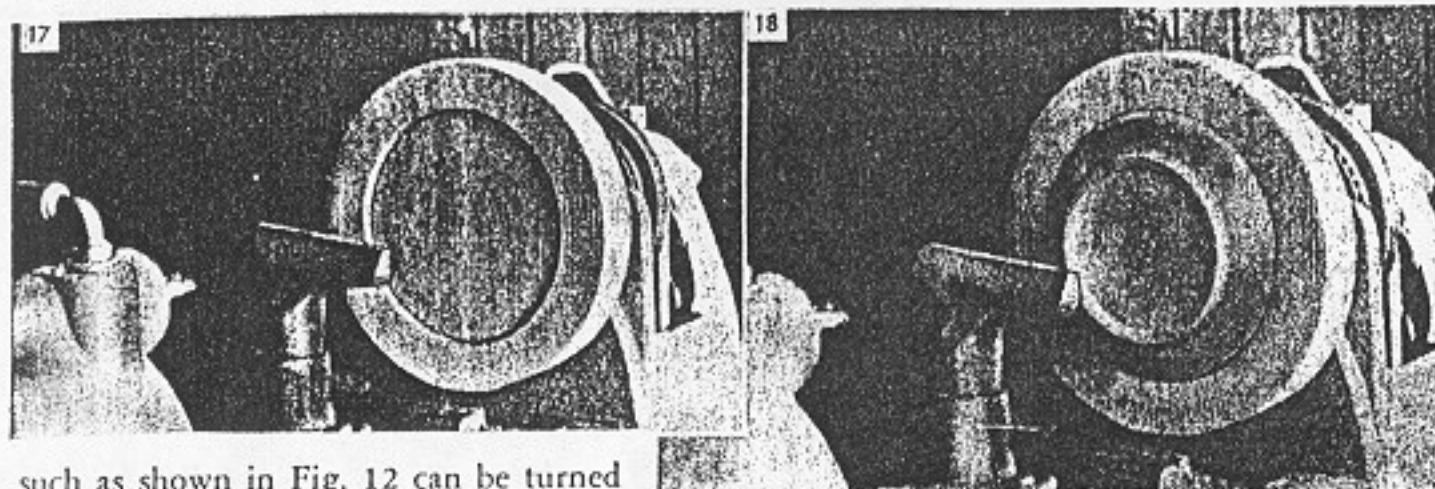
the purpose of the cores has been understood, their size can be determined for any item. The purpose of the core print is to leave a recess in the sand mold to take the core. The reason for the core in the base is to conserve metal, while the core at the small end is to leave a recess in the casting to take the candle. After the pattern has been made, it may be taken apart and the core laid out on one-half of the pattern as shown in Fig. 13. The purpose of this layout is to arrive at a definite size and shape from which the core box or core pattern may be made.

The cores are made from plain or beach sand mixed with watery syrup or linseed oil and baked hard in an ordinary oven. But first it is essential to make a core box in which the sand core can be molded to shape. Core boxes

The group at left concerns the candlestick. Core boxes, cores and a split pattern are shown



The fruit plate is made in two sections, pedestal and dish. At right, notice the doweled split-pattern for pedestal with plaster of Paris core boxes and wood pattern for dish



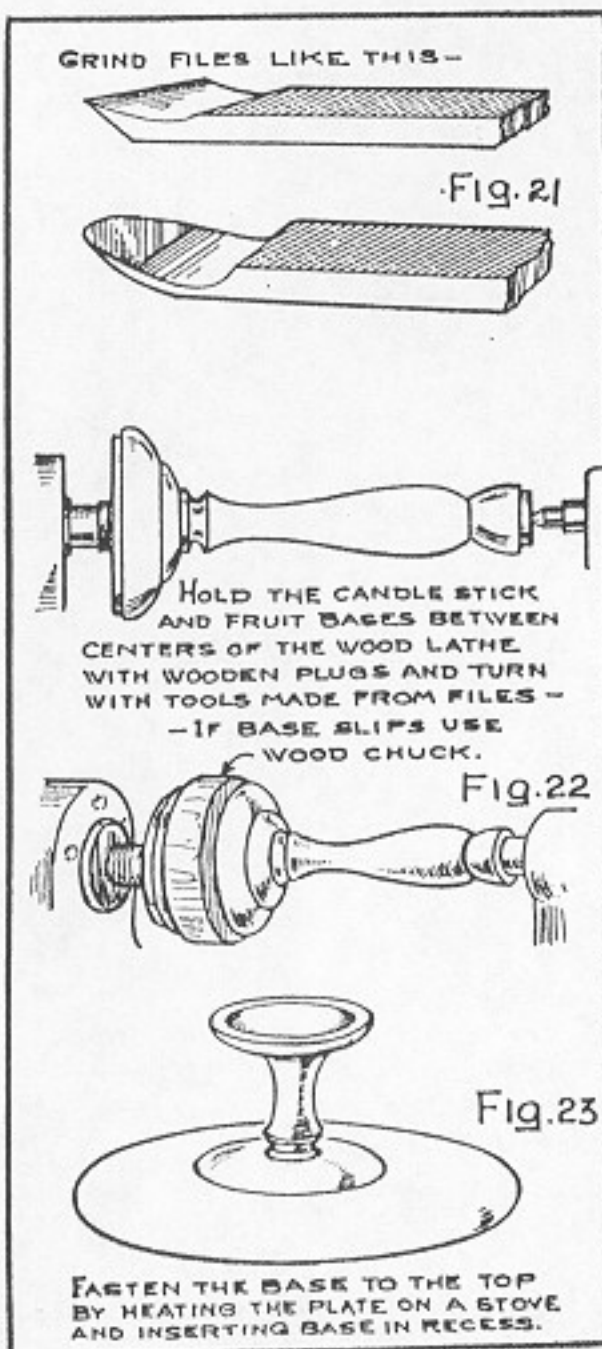
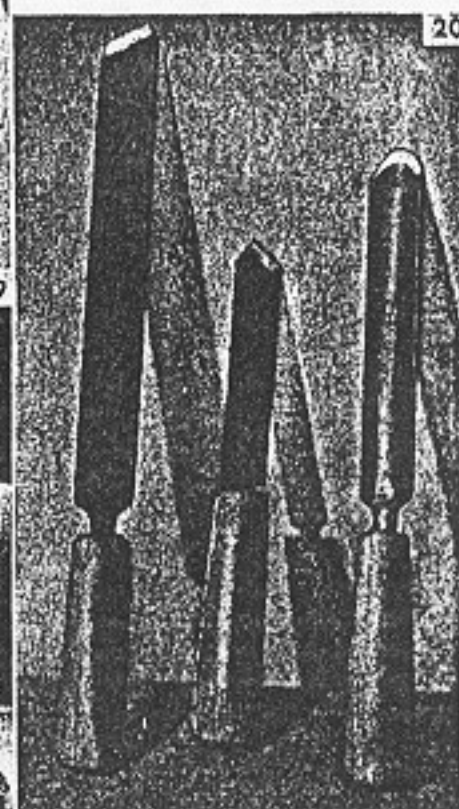
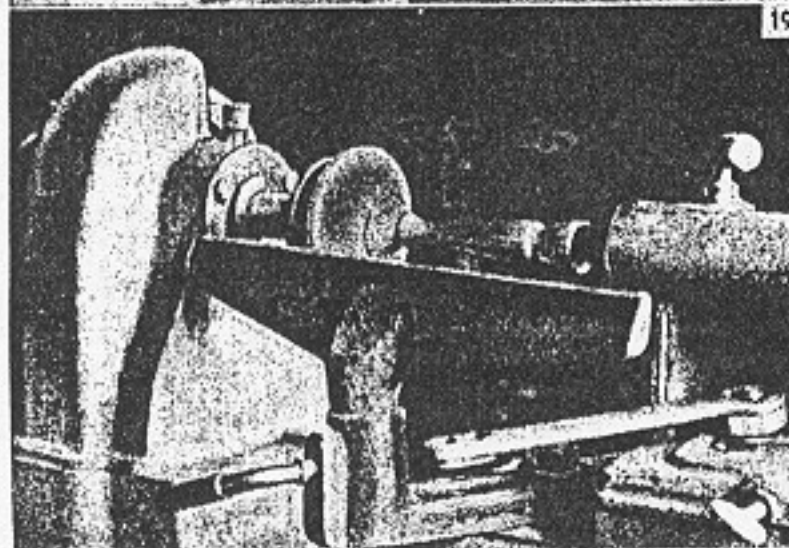
A tray is chucked in lathe at left. Old files make a set of turning tools, below. Fig. 19 shows a candlestick turned from cast aluminum

such as shown in Fig. 12 can be turned from wood, sanded and shellacked; or they may be made quite simply with plaster of Paris cast around a wooden core pattern. If the core box is made of wood, a core pattern of wood is not required, but if the core box is to be made of plaster of Paris, then a core pattern such as was laid out on half of the candlestick pattern will have to be turned. Figs. 14 and 15 show the core boxes made of plaster of Paris from a core pattern.

The fruit plate pattern is a combination of both types of pattern work; that is, the single piece and the split pattern. The pedestal, Fig. 11, of the fruit dish has a core print on the lower end only. The projection on the upper end fits the pedestal to the dish.

MAKING THE MOLD

After completing construction of the necessary equipment, the work of making the mold may now be undertaken. The green sand from which the mold is made in the flask should be dampened. Care should be taken not to have the sand wet as a mold made of sand too damp will generate enough steam when the molten metal is poured in it to "blow" the mold apart. As the dish of the fruit plate is a single piece pattern, the making of the mold for this part is the simplest and should be done first. The molding board should be placed on the bench with the pattern centered upside down; that is, the parting line of the pattern should be on the board. The drag, which is the lower half of the flask, is inverted and placed on the molding board to surround the pattern. A handful of green sand is worked between the hands to loosen all lumps before it is spread over the pattern inside the flask. Additional sand is sprinkled evenly over the surface of the molding board and tamped down with the rammer to pack



it around the mold and the flask.

When the drag has been filled and the sand leveled off flush with the edge of the drag, the second molding board is placed on the drag and the entire unit is inverted. Both molding boards should be held securely to the drag while the unit is being turned over. The molding board which is on top may be removed when the drag is in its proper position. The cope is now put in place over the drag. A thin layer of parting sand (ordinary dry sand) should be dusted over the sand in the drag before green sand is added to the cope. The sprue pins should be held in the cope at a point about 1" from the edge of the pattern with the small end resting on the sand in the drag. Some green sand should be placed around the bottom of the sprue pins to hold them in place while the sand is placed and tamped in the cope.

After the cope has been filled, the sprue pins are drawn out of the sand to leave holes through the cope. The cope is lifted free of the drag to expose the pattern in the drag. Marks will be left on the sand in the drag by the ends of the sprue pins. Small channels, or gates, are cut in the sand to reach from the mark left by the sprue pins to the patterns. These gates allow the metal to flow into the mold. All loose sand should be blown away from the drag and

the pattern may be removed with the aid of a sharp ice pick. The point should be driven into the pattern at an angle so the pattern can be lifted free of the drag. The cope is replaced and the flask is ready to take the metal. Fig. 5 shows a cross section of the flask with the pattern, sprue pin holes and gates in their respective positions.

The making of the mold for a split, or two-part, pattern is accomplished in very much the same manner. The pattern has two parts, the cope and drag. The cope half of the pattern is the one in which the dowel pins have been glued. The pattern is split and the drag half is placed on the molding board with the flat surface down. The sand is spread and tamped as described for the making of the mold for the fruit dish. After the drag has been turned right-side up, the second or cope half of the pattern is placed on the first or drag half which is still in the sand. The cope of the flask is placed in position and then filled with sand, with sprue pins inserted as before. The gates are cut after the cope has been removed. The patterns are taken out of the sand and the cores carefully inserted in the core prints.

CORE BOX AND CORE

The purpose of a core in foundry work is to leave a recess or hole in a casting. The core which is used in a mold is made of sand which has been mixed with syrup and baked in an oven. The syrup acts as a binder and the baking dries the oil rapidly and produces a mass of sand that is extremely solid and firm. A core properly made will withstand almost any amount of abuse. As mentioned before, there are two methods of making the core box in which the core is made. In any case, it should be kept in mind that the core should have an outside diameter equivalent to the core print which is on the wooden pattern. If the end of the core which sets into the core print in the sand mold is not of the same size, the core will either fall out of place or it will break the mold. When the core box has been made, the sand mixed with the linseed oil is tamped into the core box. It is then removed by inverting the core box and tapping it lightly until the core drops out of the box. The core box must be close to the bench as the core at this time is very fragile. After

the core has been removed from the core box, it is baked.

The furnace is started up with the crucible inside. Enough time must be allowed for the crucible to become heated. When the crucible is ready to take the metal it will show a glowing heat. The aluminum is cut up into small pieces and dropped in the crucible. It is unwise to put in too much scrap metal at one time, and no more metal should be added until the first batch has been melted. If large pieces of metal or a great amount is put in at one time, it will take a considerable length of time to melt. The metal should be heated to a point where it will flow freely but it should not boil. It is of the utmost importance that a graphite or clay crucible be used as these materials will hold the heat and thereby keep the metal molten while it is being taken from the furnace and poured into the mold. It is needless to say that a pair of tongs is required to handle the crucible. Be sure that enough metal has been melted to complete the casting as it is impossible to pour more metal into the mold once the metal previously cast has set. If sufficient metal has not been prepared, and this is discovered after some of it has been poured, the mold will have to be broken apart and a new one made.

After the metal which has been cast has had time to cool, the mold is broken apart and the casting is removed. One of the photographs shows the casting of the dish with the metal from

the gates and sprue holes still attached. This excess metal is removed with a hack saw.

The dish and fruit plate castings are turned in the lathe while being held in the headstock by a wood chuck. Moderate speeds are advisable. Fig. 17 shows one of these chucks made to take the dish. The bottom of the fruit plate is turned first as shown in Fig. 18. The plate is then removed and re-chucked so that it can be held in place by the foot of the tray.

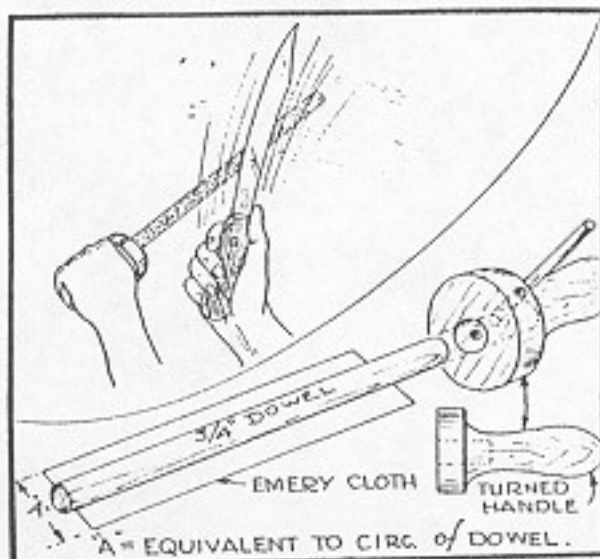
The candlesticks can be held in place by plugs of wood fitted to the cored parts of the casting. Fig. 19. The spur center is attached to the larger block of the base. If the work slips by this method, a chuck can be made on the faceplate and the base centered in it.

The lathe is run at a moderate speed for all metal-turning work. The tools are made of old files, shaped very much the same as woodworking tools with the only exception of top rake. Figs. 20 and 21 show the shape of these tools. Most classes of work can be smoothed with fine emery cloth and polished with jeweler's rouge on the lathe.

The base of the fruit plate is fastened to the pedestal by the shrinking process. Turn the recess slightly smaller than the end of the pedestal to be fitted. Heat the base evenly but hot, and while in this state insert the pedestal in the expanded recess. Fig. 23. If desired, when the polishing is complete, the surfaces can be decorated with a ball-peen hammer.

Popular Homecraft May-June '37

Dowel Wrapped with Emery Cloth
Makes Practical Knife Steel



HERE'S a practical idea for the construction of a knife steel that will be of service in the kitchen as

well as the shop of the home craftsman. All that is needed is a piece of dowel about 12" long and $\frac{3}{4}$ " in diameter, a sheet of fine emery cloth and some glue.

The surface of the dowel that is to be covered with the emery cloth is covered with glue. The emery cloth is then securely wrapped around the dowel leaving approximately 1" on one end as a means of attaching a handle. Lathe turn, or whittle by hand, a wooden handle and bore a hole to receive the dowel.

A small hole can be drilled in the handle and a string inserted so that the steel can be hung in a convenient place. As the emery cloth becomes worn, it can be unwrapped and replaced.—A. C. Mayham.



THE HOME CRAFTSMAN MAY-JUNE, 1937

This simple play boat for youngsters, built in a few hours' time, will yield a full summer of fun.

PADDLEBOAT FOR YOUNGSTERS

EVEN the most frolicsome of old swimming holes will be panic stricken this summer when it greets this paddleboat. Because of its flat bottom and square ends it will not capsize easily and it is buoyant enough to support as much as four hundred pounds without danger. Complete, it weighs 35 pounds. Lumber costs slightly less than three dollars. It is as easy to build as an ordinary box and the construction requires only the simplest equipment—hammer, saw, plane, brace and bit.

The side planks are made of $\frac{3}{4}$ " x 10" white pine measuring 6'-9" long. In order that the boat may be rowed with as little resistance as possible and so that it may travel in either direction, the two ends are equipped with slant boards. Each end of the side planks, therefore, must be mitered. Reference to the working drawing shows that this miter begins 5" from the top edge and extends $5\frac{1}{2}$ " from the end. Mark off these

Bill of Materials				
No. Pcs.	Th.	W.	L.	Remarks
1	$\frac{3}{4}$ "	5"	6'	3-ply bottom
2	$\frac{3}{4}$ "	10"	6'-9"	Sides
2	$\frac{3}{4}$ "	5"	2'-10 $\frac{1}{2}$ "	Ends
2	$\frac{3}{4}$ "	7 $\frac{1}{2}$ "	3'	Slant ends
32 lin. ft.	1"	2"		Furring lath braces
1	$\frac{3}{4}$ "	8"	2'-10 $\frac{1}{2}$ "	Seat
2	$\frac{3}{4}$ "	6"	2'-10 $\frac{1}{2}$ "	Deck boards

two points and saw off the corner. Now cut two end boards of $\frac{3}{4}$ " x 5" stock, 2'-10 $\frac{1}{2}$ " in length, and dress the bottom edge with a plane. Deck boards should measure 6" wide by 2'-10 $\frac{1}{2}$ " long. The slant ends are made of $\frac{3}{4}$ " x 7 $\frac{1}{2}$ " stock and they should be cut to 3' length because they extend over the side planks, whereas the ends and the deck boards reach between the side planks.

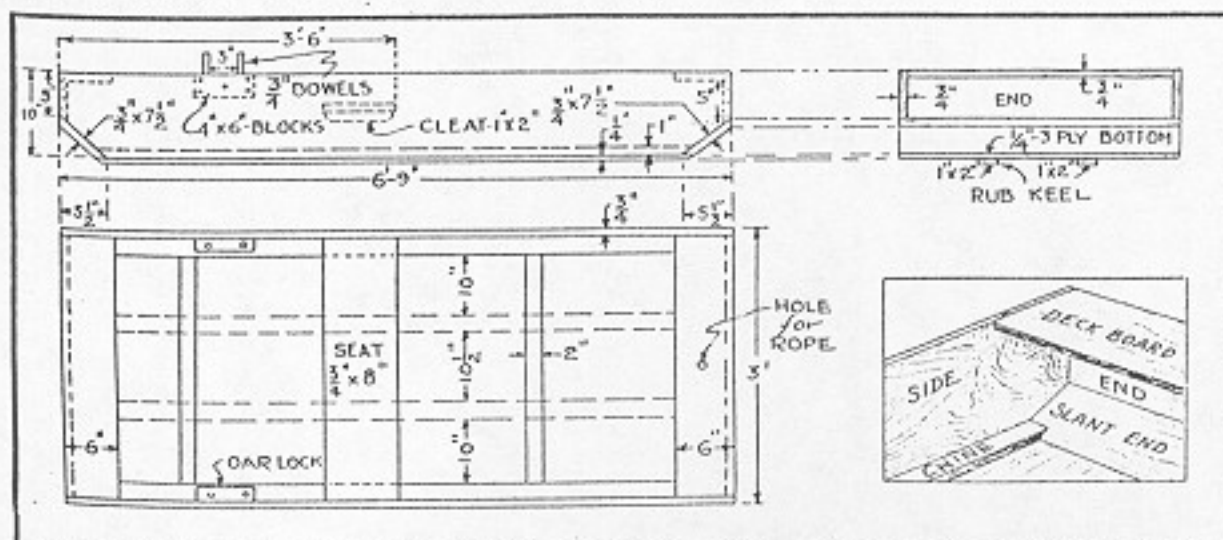
Assemble the ends between the side planks with tenpenny nails and follow with the deck boards and last with the slant ends. Waterproof glue, or marine glue, should be used in addition to nails for fastening.

The bottom consists of a single panel of 3-ply wood, $\frac{1}{4}$ " thick. A

3' x 6' panel is required. Before attaching it to the under edges of the side planks be sure to plane the lower edge of the slant ends so that this edge comes flush with the bottom edge of the side planks. Now attach the plywood bottom, using again glue and nails or screws. Fasten two furring laths lengthwise of the hull on the underside of the bottom panel to reinforce this bottom.

Now turn the boat right side up and cut three pieces of furring lath to fit across the hull inside, on the bottom of the boat. Fasten these pieces with nails driven through the side planks. Then lay strips of lath in the lower corner of the boat, from front to back. These strips form a reinforcing chine. Turn the boat over and drive nails through the bottom and into the chines as well as the crosswise bracing.

The seat, a piece of $\frac{3}{4}$ " x 8" stock, is supported by cleats of 1" x 2" x 7" stock nailed to the side planks at a point 6" off the floor. Oar locks should be installed about 15" from the back edge of the seat where two blocks, 4" x 6", are nailed to the inside of the planks so as to be flush with the top. Two holes, bored 3" apart with a No. 14 auger bit, in the top of these blocks will accommodate $\frac{3}{4}$ " dowels which should be allowed to project to form an oar lock. In one of the deck boards bore a hole so that a piece of $\frac{3}{8}$ " rope tie line may be inserted through the hole and knotted. Three coats of oil paint complete the paddleboat.





A CAMP.

CENTURY MAGAZINE
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AMONG THE APACHES.



LOCO.

AMONG the few great Indian tribes that cover vast areas of land and are so numerous in population that they are divided into many petty clans, we find the Apaches of the south-western part of our country holding no small place.

The Apaches are divided into no fewer than seven principal clans, which acknowledge no

common chief or chiefs, and have but little sympathy in common, even warring against one another under the stimulus of bribes,—the pitiful pay of a soldier often being sufficient to ally them with their common enemy, the white men, against any of their brothers in blood.

The word *Apache*, converted back into its own language, signifies *people*, and is synonymous with many tribal names among savage nations,—as *Lacotah* or *Dakotah* with the Sioux, and *Innuvit* with the Eskimo.

The first conquest of the Apaches by civilization, imperfect as the conquest was, came from the inroads of the Spaniards who had overrun old Mexico. It was more of a peaceful conquest than those old Castilians were wont to make, much of it being, through the medium of the Spanish Jesuits, of a religious nature, and so early was this conquest that Santa Fe and Albuquerque, long considered frontier posts, claim priority over St. Augustine, the first city of the Atlantic. One Cabeça de Vaca appears to have been their first military conqueror, and they seem fortunate that in him there did not exist in cruelty and tyranny another Cortés or Pizarro. Nor is this comparison wholly our own, for it is affirmed that the Apaches,

singular as it may seem, know of the name and doings of Hernando Cortés, probably through intertribal tradition, and picture him alongside of de Vaca much to the detriment of the former. In fact, it was explained to me that Cabeça de Vaca, meaning a cow's head, was but the Spanish translation of the Apaches' name for the first soldier among them, and was thus given because the feast of the cow's head was then held in reverential esteem.

From Spanish rule, with the liberation of Mexico, they passed under the new government, and after the Mexican war with us the resulting boundary ran ruthlessly through the heart of their country, paying less attention to them than to the barren lands which it divided, and which for untold ages had been their home. Nor did the thin sabulous strip known as the "Gadsden Purchase" do more than throw the preponderance of the great tribe upon our shoulders.



MANGAS.

small way upon their success in raids upon the white people; and from this standpoint they oscillated in friendship or enmity from one side of the border to the other with an alacrity that should rank them high among the diplomats of fame. On one side hung high the fair flag of truce, and on the other, as at half-mast, the black standard of no quarter; and with such deadly and cruel effect was this alternation made, that we saw the

humiliating spectacle of two civilized nations, claiming rank among the nations of the world, sitting in solemn conclave to devise a common plan that would annihilate a batch of breech-clouted bandits whose whole numbers would not have made the hundredth city in either land, and to do this surrendering the highest prerogative of national sovereignty—the sacredness of their soil—to the soldiery of the other. Once Victorio, a presumptuous and daring chief of Apache land, dared to flaunt the three hawk feathers of his lance in the faces of the eagles of both the North and South; and all conversant with Indian history know how that chief met his tragic death, after being driven weary, exhausted, and hungry across the boundary line into the arms of the Mexican soldiery, where he and the greater part of



BONITO.

his band were swept from the face of the earth, Victorio dying fearlessly at the front as became a chief.

My first visit to Apache land was in 1871. Then the favorite route to Arizona was to round Cape St. Lucas of

Lower California, sail through the gulf until the mouth of the Colorado was reached, up which shallow river boats plied and distributed passengers for the few river villages and inland points where a scanty population wrested a precarious existence. From the mouth of the Colorado River it was deemed necessary to send through a courier with dispatches to Fort Yuma, distant ninety miles, I believe, by the trail. Three long days we were steaming up the swift, shallow, and tortuous river, and when we did finally reach Yuma we found that our courier, a lithe, active, young Yuma Apache, had slipped across the trail in thirteen hours, or at the rate of about seven miles an hour the whole distance. Dressed in the uniform that their Creator issued to them, with perchance a dangling necklace or armband of beads to ornament it, and a homeopathic breech-clout, these sinewy deer-hounds of the desert, with fists clinched across their breasts, with a mouth full of messages, will keep up a "dog-trot," hour in and hour out, for a time only limited by that which is necessary to reach their objective point, however far it may be away,—and this too across valleys carpeted with cactus, and hills and mountains beset with flinty footings. Some of their running feats of endurance are marvelous to relate, and are oftentimes made in a withering heat that makes life in the open field burdensome almost beyond bearing to the white man.

These Yuma Apaches are the most westerly of the family, living along the Colorado River in its lower part in Arizona, while on the upper part is found the Mojave branch, two sub-clans almost identical in many characteristics. They alone of all the great Apache tribe cremate their dead, a cremation so effectual that it does not cease with the body, but includes all the personal effects, however valuable, even to their *wick-e-nps* (the universal Ari-

zona expression for their rude houses).

These *wickeups* (as I notice the spelling in an Arizona journal) are made of a circular row of long lithe brush, bent down toward the center and interwoven into a rough semi-globular shape, not unlike the half of an egg-shell on its rim. Over this is thrown other brush and a light sprinkling of dirt as a protection from the sun's rays. When these materials are scarce, mud is used as a substitute, the wealthier class being sometimes supplied with a piece of canvas. Their more permanent abodes are now and then made by digging into a steep dirt bank at an expenditure of muscular energy that one would hardly think possible among any band of Indians showing such squalor and laziness in every other department of life.

The dialectic difference in the Yuma and Mojave Apache pronunciation of their common language is not noticeably great, but these again, on the contrary, differ from all the other Apache tribes to an extent apparent to persons who make no profession to linguistics. Theirs are the harshest and abound the most in guttural inflections of all the dialects of this desert tribe, some of which are toned down to a softness quite pleasant to the ear, although these extremes readily comprehend each other.

Once the Yuma and Mojave bands held high rank as warriors among the Apache tribe, but their country being easy of access, they were the first to succumb to civilization, and have gone a long way on that road of extinction which is marked out to those peculiarly tempered savages who can absorb only the vices and but few of the virtues of such a contact.

To combat their ailments they have only the usual superstitious rites of a few ignorant "medicine-men," and occasionally make use of those heroic and barbarous treatments so common with savages. One of these I think may be interesting. A great hole, large enough to receive the body of the invalid in a recumbent position, is dug in the ground. In this excavation a fire is maintained until the ground is heated to its greatest possible extent, when the embers and ashes are scraped out. Several layers of damp mud are immediately used to plaster the walls of this fiery furnace, and the invalid is then placed within and covered up with mud, the head alone protruding. The escaping steam makes the torture endured by the poor wretch, for the thirty-six to forty-eight hours of misery in the prison of baked clay, oftentimes insupportable, and but few survive the severe ordeal. A Mojave squaw, with the Americanized name of "Polly," rallied from this terrible inquisition, but it took the kindest treatment for two months under the care of a white physician to save her life.

Nearly all the Apaches are addicted to tattooing, their faces and wrists being usually

adorned, and, as far as I casually noticed, there being no difference between the men and women. Paints and pigments of all characters are eagerly sought for temporary personal ornamentation, the Yumas and Mojaves even descending to stove-polish, boot-blackening, and mud. Undoubtedly the latter, in some of its applications, serves a more practical purpose than mere ornamentation. A thin coating of soft clay is matted through the hair and then plastered carefully down upon the skull, until it resembles, when dry, a shining bald head or an inverted earthen bowl. This is left on for two or three days, until it has subserved its purposes of deadly destruction, when the earthy skull-cap is broken with a stick and the beating process continued until every particle of dust is thoroughly eradicated, when the hair is washed with the soft pulp of the root of the Yucca palm, which produces a soapy lather. After this the hair is energetically rinsed and then whipped in the open air until dry. From all this manipulation it emerges as glossy and as soft as silk.

This Yucca palm is commonly known as the Spanish bayonet and oftentimes as the soap-weed, the latter name being evidently derived from this peculiar use by the Indians and Mexicans. It is one of the most extensively common plants of Apache land and contiguous countries, and it is well for those localities that a commercial use has been found for this abundant weed, its pulp, according to recent experiments, bidding fair to give a very fine grade of printing-paper. Thus the vulgar soap-weed that cleanses the outside of the Apache's head may yet improve its interior through the medium of the press.

The most barbaric forms of witchcraft have within fairly recent periods been practiced by them, especially by the two bands we have named and the Tontos, a clan of central Arizona. Among the Apaches, men are never accused of this crime, but, at extremely long and rare intervals, some luckless squaw in a village that has seen more than its share of misfortune is accused of these calamities as a witch. Either man, woman, or child can bear witness against the unfortunate, although the highest chief in the vicinity seems to be the proper one to prosecute her. The accusation once lodged, and, of course, as such complaints always are, believed without thought or trial, the entire village is summoned to the proceedings, which generally mean an execution. In carrying these on the victim is stripped to her waist and then tied up by her thumbs with strong thongs, her toes barely touching the ground. All of their devilish energies are now bent on extorting a confession from the wretch. Any of those who have had any misfortune, however remote, imaginary, or real, are at perfect liberty to flay the supposed witch with mezquite or willow switches until she faints from exhaustion, or terror and weakness forces a false confession in the vain hope of obtaining relief from her terrible condition. If she will not thus please them, the whipping is kept up until the executioners themselves are exhausted, when one by one they leave her to die, which results unless she be lucky enough to liberate herself from the thongs after the last one has departed. Should they wring a confession from her, she is beaten to death

with stones and sticks, and all of her property burned, even to her rude house and ruder utensils.

On ordinary deaths, these Apaches mourn for a few days in wild plaintive cries that the uninitiated might mistake, at a distance, for the cooing of the turtle-dove. The nearest relatives cut off their hair as close as possible, and their mourning is kept up until the hair grows out. All these latter rites are denied the poor wretch executed for witchcraft, but she is still entitled to a burial at the hands of her relatives if they make no display to insult the superstitious dignity of the tribe.

There are but few other superstitions that have such disastrous results in their applications. It would almost seem that they had some supernatural dread of water, and this in a country where that fluid is conspicuously scarce. Fish never enters into their diet, although they are not hard to procure, and they repel them in a way that can only be based on superstition. Canoes are never used, although an occasional raft is made to transport effects in one direction, and, in general, a river is of no more use to them than furnishing drinking water or establishing a flat valley in which they can travel more readily on foot or horseback. In this way all traveling is done, and all household effects are transported either on the backs of horses or of squaws, the women generally predominating. Some of the muscular feats of the latter, while thus engaged, even rival the endurance and strength of the stronger (?) sex, as shown in their runners. A Yuma squaw has been known to carry over three hundred pounds of bulky hay between four and five miles over a mountain road and without stopping on the way. Not much was left to the imagination of the story-teller either, as the hay was weighed on tested scales and the route pursued was a well-known measured one. More marvelous cases are heard of occasionally, but they are not so authentic.

Birds are also rejected as food, although they are used in cases of distressing scarcity; especially the wild turkey, which stands better in their estimation. Other native articles of diet, on which they yet subsist to a certain extent, are baked *mezcal*, the bean of the mezquite tree, the fruit of the giant cactus, and the prickly pear. To furnish them with meat they find extensive variety in the black and white tailed deer, antelope, bear, ground-rats, rattlesnakes, and rabbits (hares). Nothing exists to show that the Apaches were ever cannibals. No part of a slain animal is unused, even the smallest bones being broken open in order to save the marrow.

No drink-loving old toppers ever enjoyed their liquor so much as have the Apaches whenever they could procure it, a vice, however, that is rapidly subsiding as the tribes are concentrated at agencies more directly under the eyes of watchful authorities. *Mezcal*, made from that plant by the Mexicans, found its way in days gone by, when population was scattering and the laws lax, into



OLDEST APACHE ON THE RESERVATION.



HEAD WARRIOR OF CHIRICAHUA.

Apache maws with every trade and dealing between the two races. From corn they make a fermented drink called *tis-win*, which is not as strong as the corn-whisky of civilization, but their peculiar method of drinking it compensates for its lack of strength. For some three days before it has reached its highest point of fermentation not a single piece of food is swallowed. At the end of that period they fill themselves to their utmost capacity with the unclarified *tis-win*. Although half starved, it takes but a few moments to make them feel as if they had had a major-general's rations for six months previous, while the most conspicuous effect is to swell their bump of combat-



NAT-TZUCK-EI-EH.

iveness to an inordinate degree. If a large number have indulged in this liquor, serious outbreaks and disturbances are almost sure to ensue, especially if other bands of Indians or any whites are near enough for them to reach before this temporary, stimulated combativeness has worn away. In fact, after having, when sober, decided to go upon the war-path, by far the most important preliminary is the manufacture of huge quantities of *tis-win*. Its peculiar composition, and the no less peculiar manner of taking the liquor, gives it a most lasting effect upon the system, and an Indian with his stomach distended with it is said to have ahead of him a six to eight days' "spree," and during all this time his warlike qualities are sure to be most conspicuous.

There is much evidence to show that alcoholic liquor made from corn is an ancient drink with these people, everything that was necessary to manufacture it being found in their old ruins, and under circumstances that make such a conjecture not unreasonable. Even in the caves of the old cliff-dwellers of Arizona there have been found cemented deposits of corn so ancient that when disturbed the grains fell from the cob a mass of impalpable powder, leaving the cob, singularly enough, as fresh as if it had been gathered but the harvest before.

To ramble for a moment from the main subject, in considering the ancient cliff-dwellers of Apache land,—I was

not a little surprised to hear of many cliff-villages yet unexplored. An idea prevails that the cliffs and caves of Apache land have been nearly all included in the researches of archaeologists and curiosity hunters. An old Apache of San Carlos agency, whose perfect confidence had been won by a government official, spoke of many that he knew had never been inspected and that were full of relics. He wished to conduct his confidant to a place not far distant. He added that only a small part of the remains known to the Apaches had ever been examined.

San Carlos agency, on the river of the same name, is the great central point where the Government has gathered from time to time the greater portion of almost all the Arizona bands of Apaches, who are slowly acquiring the arts of peace and will soon be a useful part of the agricultural population of that region. Here from the eastern boundary are bands of the Yumas and Mojaves, of the Tontos and San Carlos Apaches from the central districts, and of the Sierra Blanca tribe from the north-eastern corner. The only important Arizona band not directly represented are the warlike Chiricahuas, and they are quartered on the reservation of which this agency is the headquarters,—except the leaders, recently surrendered, who have been exiled to Florida.

Their partly civilized, partly barbaric agency-life is not uninteresting in some of its aspects, especially while the barbaric element yet predominates. The Government has cultivated their martial feelings, and at the same time turned them to its own account, by enlisting the most trusty warriors as soldiers in its own service, and using them as a police and detective force against one another, and especially one tribe against another. No less than three full military companies of these scouts were, until recently, distributed among the Indians of this great agency; and as the white soldiers were at the same time placed at distant points on the boundaries of the reservation, the Indians were thereby lifted a little in their ideas of sovereignty and self-government.

In every cluster of *wickieups*, and in fact in almost every family, might be found one of these scouts, acting in the interest of the Government, and forming, in effect, a secret detective system more efficacious than the detective bureaus of civilization. While every crime was reported to the white chief-of-scouts, care was taken that the informer should never be known. But not long ago Ki-at-ti-na, the head war-chief of the Chiricahuas, tired of the monotonous restraint of the military, gathered around him a few of his belligerent band, still footsore from the war-path. They indulged in a preliminary war-dance, and, sending couriers to all likely to join them in an outbreak, impatiently awaited results. The chief's fleetest courier was a spy, who gave timely warning of all the concerted movements and intentions before an advance was really made. The chief's first intelligence of the result of his plot was his arrest by the scouts of his own tribe

and his arraignment before the authorities at the agency.

An Indian accused of any crime is tried before a jury of Indians, and when Ki-at-ti-na had gone through all the processes of his trial, there hung over his head a three-years' sentence in the penitentiary at Alcatraz within the Golden Gate. Even death has been meted out to offenders by Indian juries. A guard-house inclosed less refractory criminals, and through one of its windows peered the face of an Indian sentenced for life.

These Indian soldiers, in all that pertained to arms, ammunition, pay, and rations, were on exactly the same footing as other soldiers in the service, except that their term of enlistment might be variable. A calling of the muster-rolls sounds like that of Hungarian Hussars or Polish Lancers, a deception of the ear that an inspection of the written names would not confirm. Their savage passion for finery and display cropped to the surface in an inordinate desire for military parade and exhibition, even to the extreme of monotonous drill, but much has been denied them in those particulars, as on their primitive *status* rests much of their efficacy as scouts against other bands.

In one of the last and then one of the most important and decisive campaigns waged against the most warlike band of the Apaches, the Chiricahuas of south-eastern Arizona, all of the friendly Apachescouts were employed and but one company of white troops, and in the contest which ensued in the broken mountainous defiles of the Sierra Madre of Mexico none of the white troops were used. Their endurance and rapidity of action are superior to that of white men, for they literally crawl in the grass like snakes, and creep and dodge through the rocks like squirrels in the branches of trees in their densest foliage.

Portraits of some of their most famous scouts are given. Nat-tzuck-ei-eh, a Chiricahuasquaw, was one of the most important against her own tribe in the campaign into Mexico just alluded to. Even before the main command had started she departed alone and on foot to determine the whereabouts of the hostiles in the fastnesses of the Sierra Madre mountains. On this trip she was absent for about six weeks, unceasingly prosecuting her object. A Chiricahua herself, it was evidently her intention to gain the Indian camp, claim that she had been captured by and escaped from the whites, find out all that she could, and then at the first favorable opportunity prove traitor to her tribe. Treachery is a distinguishing feature of the American Indian, but it is almost wholly a trait turned to account against the enemies of the tribe. Even the lowest Digger Indian has some faint conception of honor in his tribal relations in war, and among some it compares well with, if not exceeding, that among civilized nations, but the Apache seems to have absolutely none.

The painstaking labor to which



T'OO, OR "PEACHES."



CHI-HUA-HEE.

they will go to emphasize their cruel treachery seems almost fiendish in the extreme. "Way back in the 50's" an emigrant family, winding its toilsome way through the burning desert of the Gila valley, on the road to California, found themselves, with an exhausted team, at the bottom of a steep hill, up which they vainly essayed to ascend. A band of Tontos Apaches, bent on some fiendish foray, passing that way, came upon the scene and at once willingly offered their services to carry their effects to the top of the hill. Not only did they do this, but the empty wagon was spared to the exhausted horses and hauled up by hand. This wonderful act of kindness was terminated by the massacre of the owners on the crest of the mesa, while all unawares they were reloading their wagon, the only object of their pretended friendship being undoubtedly to secure this condition of apparent safety. I visited this spot over a decade later, and some four or five whitewashed head-boards, encircled by a neat fence of native mezquite brush, kindly placed there by some frontiersmen, were not only monuments to the dead, but to as foul a piece of treachery as was ever perpetrated by one of the most savage tribes.

It will be seen that Nat-tzuck-ei-eh's nose has been somewhat abbreviated, an old mode of punishment among them for the highest order of marital infelicity that has been stopped by the authorities along with other cruel punishments. In virtue and modesty the eastern Apaches compare favorably with the best of Indians, but unfortunately the same cannot be said of the western tribes.

The most important scout in the campaign noted above was one T'zoe, whose translated

name is said to mean "Peaches," at least, he was known by this latter name among the white people of Arizona. T'zoe had long been held in distrust by his tribe, and he deserted them in order to save his life,

which, from their low mutterings and half-concealed threats, he believed to be in danger, knowing right well the Indian character, that they waste no time in hearing the arguments of the one fully accused. Going to the nearest agency, the San Carlos, was a jump "from the frying-pan into the fire," as he was immediately imprisoned, tried, and sentenced to death. The general revolt of his tribe, however, made him more useful to the Government as a guide than as a corpse, and he was spared the latter alternative by accepting the former, and right well did he do his work. It seemed singularly dramatic that this forced outcast of the tribe, compelled to flee for his life to a place where life was not even sure, should in so short a time be leading back into their mountain stronghold an army of his kith and kin that stretched a third of their warriors over the pinnacled field.

While General Crook was in the Sierra

Madre mountains on this campaign after the Chiricahuas, many never before imagined sites of ancient races were discovered, and in such vast extent as to be almost bewildering in magnitude. There seemed to be a series of colossal steps or terraces made by man, the lowest of which, near the streams, was evidently inhabited by these crude and ancient people. On the tops of these hills or mountains, around whose sides the steps or terraces appeared, and apparently independent of them, were immense and extremely effective fortifications for the rude weapons they then must have had, a sort of rallying point of defense for the people living near the streams. Why these terraces, between the stream where they dwelt and overlooking fortifications where they probably fled in danger, should have been constructed it seems hard to conjecture, unless it is possible that they lived near a constantly hostile and active enemy of which they had the greatest fear, and these, although for protection, were their garden-plots or limited



KI-AT-TI-NA.

grazing-grounds for their goats. An incline would have been as good, and would have cost no such immense outlay of labor in building the retaining walls. In many places through these rude structures had protruded the large pines of the country, some of which were two to three feet, or even more, in diameter. Everywhere, often in no small quantities, could be found their pottery, huge stone mortars for grinding corn (called *me-tates* in the vernacular of the country), and stone implements of war, and axes and hatchets. Under the overhanging cliffs were found caves that had once been inhabited, one series of apartments having no less than twenty-two rooms. Over one of these rooms was a large granary, capable of holding many bushels of grain. Here were corn-cobs, showing great age, mixed with pottery and stone axes. On the walls of



GERONDIO.

these rooms were hieroglyphics and pictured representations, none of which were copied or secured. It seems not unreasonable to argue from their cheerless homes and mighty fortifi-

cations that this was an inferior race of people in the age in which they lived. Even the Apaches who have made these labyrinths of lava their hiding-places superstitiously avoid these old ruins, and perchance this very fact may have saved to science valuable archaeological matter when the time comes for the investigation of these strange ancients.

Superstitions are shown in their dress and ornaments, or rather in the charms which adorn and compose these. The medicine jacket and belt are common to the whole Apache family, and are about the counterpart of similar dresses so common with savages. From the head of the

Chiricahua hangs a single buckskin string about two inches wide and as many feet in length, its upper end braided in the hair. This is ornamented with all the different pieces of shells they can obtain, and for which they seem to have a reverence, while beads and ornaments of silver and other metals help to cover it with an almost solid coating of decorations.

Maidens may be distinguished from matrons by the peculiar arrangement of their hair, the former wearing what in their language is called a *nah-leen* (*nah-leen* strictly interpreted is maiden). It is flat and of a beaver-tail dumb-bell shape, covered with red, and closely studded with gilt buttons, if procurable, the hair being tied up with this to prevent its flowing over the shoulders as with married squaws. In general, it may be said that the eastern tribes, Sierras Blancas and Chiricahuas, are far finer in dress than those of the western parts, the Yumas and Mojaves, the intermediate tribes of San Carlos and Tontos being also intermediate in dress. Still farther to the east in New Mexico are the Mezcalero and Coyotero Apaches, also very ornamental in dress, but in other respects beyond the ken of this article in their now quiet isolation.

The war-dress of these warm-weather warriors, when actually in a campaign, is not so resplendent in buckskin and beads, nor is it so warm. A gorgeous bonnet of three hawk feathers is about the only display, and the rest has a sort of simplicity known only in the Garden of Eden. An old weapon with them was a heavy round stone at the end of a short stick, the two being wrapped and joined in a common case of rawhide taken from the tail of a horse or ox so as to be continuous and seamless. This was used like a policeman's club, and has its counterpart in the Sioux "skull-smasher," a word which describes it at once. The wild Chiricahuas used the lance, and do some good work with it in a decisive fight. Even the armed warriors use it in killing cattle and stolen stock to save their ammunition thereby, while some of the most horrible tortures practiced on their captives by these fiends are inflicted by this instrument. With the introduction of fire-arms into their warfare fell the shield into disuse. It was a gaudy appendage of the primitive savage, but it exists among the Apaches only as a relic for which they can obtain so much money from the curiosity seeker. They care but little for money, however, except to appease a craving for gambling, or to meet immediate wants.

They are behind no other savages in their love for the allurements of gambling, and use all sorts of implements, from the most intricate games of cards to the simple throwing of sticks

and hoops, and in nearly all of these games their play is one of hazard, in the excitement their horses, rifles, and even the shirts on their backs, changing ownership.

Only in their dances do they excel the physical energy put forth in their gambling plays.



APACHE MOTHER AND INFANT.

From sunset till sunrise can be heard the beating of their drums and tom-toms, and night after night is it kept up. Old squaws and young children dance until they can stand no longer, and cease from exhaustion and fatigue; a cessation of but a few minutes and they are up and at it again. Their medicine dances take place in cases of sickness and distress, to drive away bad spirits or keep them from doing harm. In these the squaws are never allowed to take a part, but in peace, weddings, and feast dances, young and old of both sexes form a conspicuous part. The "corn dance," to make that plant productive, is also a monopoly of the medicine-men, while besides all these there exists the war, the conqueror's, and the chiefs' dances, varying in type through all the possible motions and gesticulations of the human body.

The ages which some of them reach appear surprising, considering their rough mode of life in the past, which seems sufficient to end it rapidly when the physical powers begin to fail. Got-ha, a Sierra Blanca, a once famous warrior of their tribe, is probably eighty or ninety years of age, and seems hale and hearty

yet. Could this old sage of the sandy deserts concentrate the salient points of his life into a volume, it would rival the tales of Daniel Boone or Kit Carson.

Age, however, finds only a place in their councils of peace, and young blood rules in times of war, unless some mighty chief, with



NACHEZ, SON OF COCHISE.



APACHE SQUAW AND CHILD.

a record of battles that none can gainsay, bears all before him even in his age. It is a keen appreciation of the eternal fitness of things that has helped them in no small way to hold for so long the mastery of the South-west in peace and in war. One mighty chief of theirs was Cochise, a household word in the literature of Indian depredations. A Chiricahua himself, his success was sufficient to join many bands under his rule, and especially those *renegados* so common in all Indian warfares and so numerous in every band who will join every revolt without regard to tribe or cause, if the revolt only promise booty and that bloody excitement which their nature craves. For years he was the terror of all in Arizona, and for a long period before his own tribes could be turned against him the sum total of his battles placed him plainly ahead. For savage strategy and barbaric grand tactics



ZELE.

he will always be a mark in the annals of Indian warfare, and will be better known as this country settles up to that extent that it will demand a history of its own. Cochise bravely acknowledged he was out-generaled once. A military train of a score of wagons, guarded apparently by only a small platoon of cavalry, bore down through Apache Pass, where Cochise had some two or three hundred warriors in waiting, and their eyes glistened with delight as they looked at the chance of an easy capture of the hard bread, molasses, sugar, and tobacco on which they might revel for weeks. They made one wild yelling charge on the train from every quarter, when, instead of savage luxuries, there came from each wagon a blinding, crashing volley from nearly a score of well-armed infantrymen. Cochise's warriors were sent flying back like surf, and, as they fled up the steep sides of the cañon, were

picked off like squirrels in a tree. Cochise died some nine or ten years ago a natural death, a singular ending for one who had been so active in the trade of death. However much they may have hated him in that frontier land, even their legislature honored him with a conspicuous county, showing that their hatred could not conscientiously descend into contempt.

After Cochise came Victorio, whose fate has been noted. Then Nana led them for a brief period of time, and then came Nachez, son of Cochise, who rules the Chiricahua band. Juh (pronounced *Hoo*) was a noted leader, and met his death in a way that was scarcely heroic. Blindly drunk with *mescal*, he attempted to ride from a Mexican town to his village, his head buried in his hands, and his elbows and the responsibility of getting home resting on the pony's shoulders. As they crossed a shallow stream, the horse, believing it was his turn, leaned forward for a drink, and Juh was precipitated into the water, and there, with his face in that kind of liquor that he had not followed closely enough in his life, he was drowned.

Loco is an important chief, he being at one time a medicine-man. In a career uniformly good—as savages judge careers—and nowhere brilliant, it is hard to speak further of him in a contracted article.

Geronimo, said to be a captured Mexican youth, might be styled the Daniel Webster of the Apache Senate. His advice was always sought on every particular matter of state, and his influence therein was equaled by few before his incarceration in a Florida prison, as the result of the latest and one of the greatest outbreaks under him, which ended with his surrender.

Chato, Bonito, Chihuahua, Mangas, and Zele form the lesser lights in this list of leaders.

Railroads run their double bands of iron through their deserts, mines pour their ores from the sheltering sides of their mountain homes, an inexorable decree has cramped them to a corner of their country, where they now wrest a living from the soil they once trod as masters, and it may be well said that the Apache sun is near the horizon of their national destiny.

Frederick Schwatka.



WIFE OF NACHEZ.



WIFE OF ZELE.

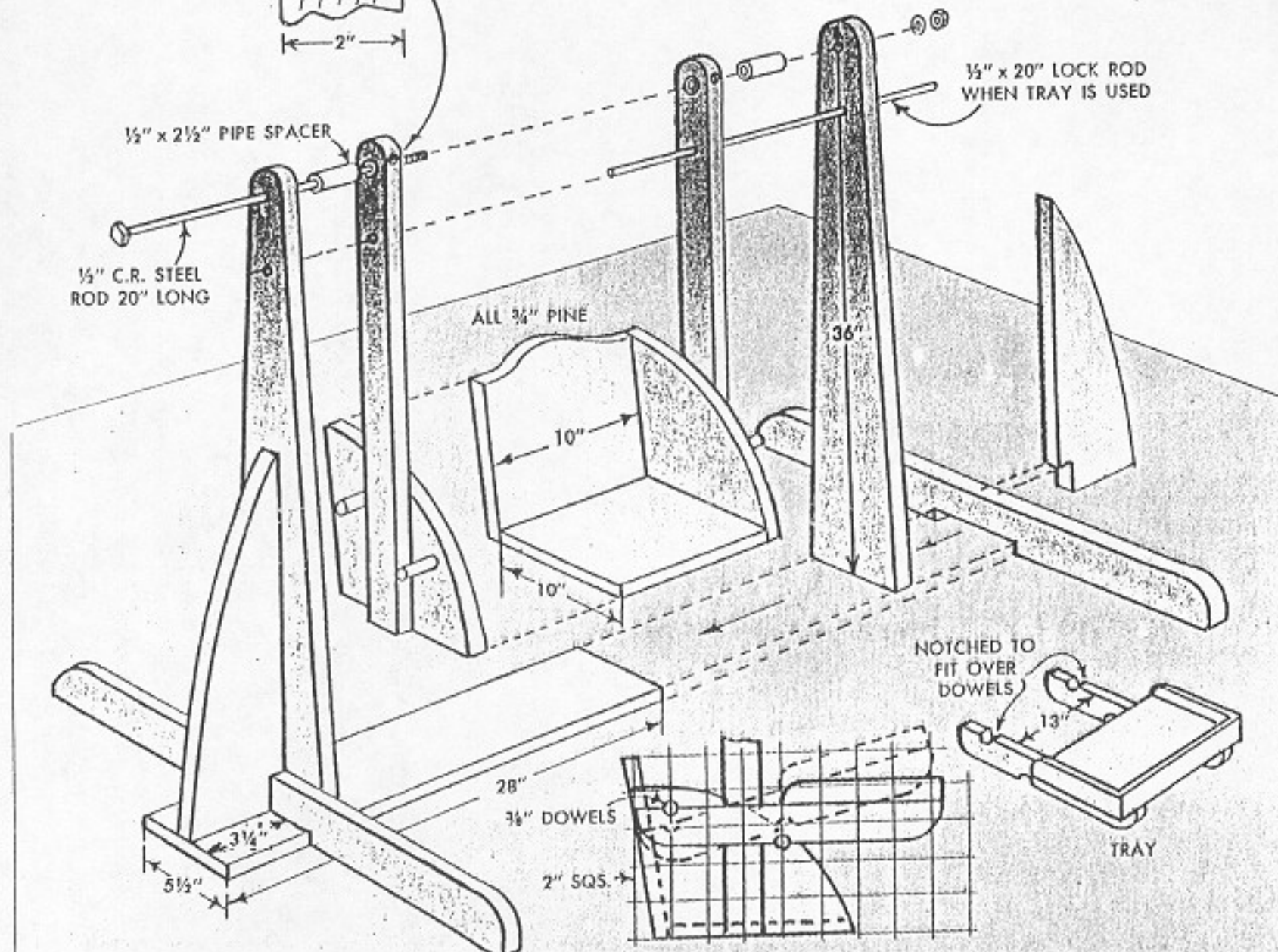
Baby Swing With Tray



Removable tray on swing is convenient play surface, or baby's food can be served on it at mealtime

Popular Mechanics 1958

LIGHTWEIGHT, yet sturdy and practically tipproof because of its wide base, this baby swing can be carried from one room to another and will stand abuse from even the most lively infant. At mealtime the swing is held stationary by a locking bar, and the tray which ordinarily keeps baby safely in the bucket seat becomes a table. Material for the swing can be $\frac{3}{4}$ -in. solid stock or plywood. The swing uprights are 36 in. high and 6 in. wide at the bottom tapering to 2½ in. at the top. Swing supports are about 26 in. long and 2 in. wide. Height of the seat above the floor is determined by the size of the baby. A rod 20 in. long provides a pivot for the swing. It is fixed solidly in the uprights of the swing stand and runs through brass bushings in the swing supports. Pipe spacers 2½ in. long keep the swing supports centered between the uprights. All joints are screwed and glued for maximum strength. Short lengths of dowel project from the sides of the seat and are located to hold the arms of the tray which are notched as indicated to hook over the dowels. For added safety, fit two removable dowels in blind holes under the arms of the tray.

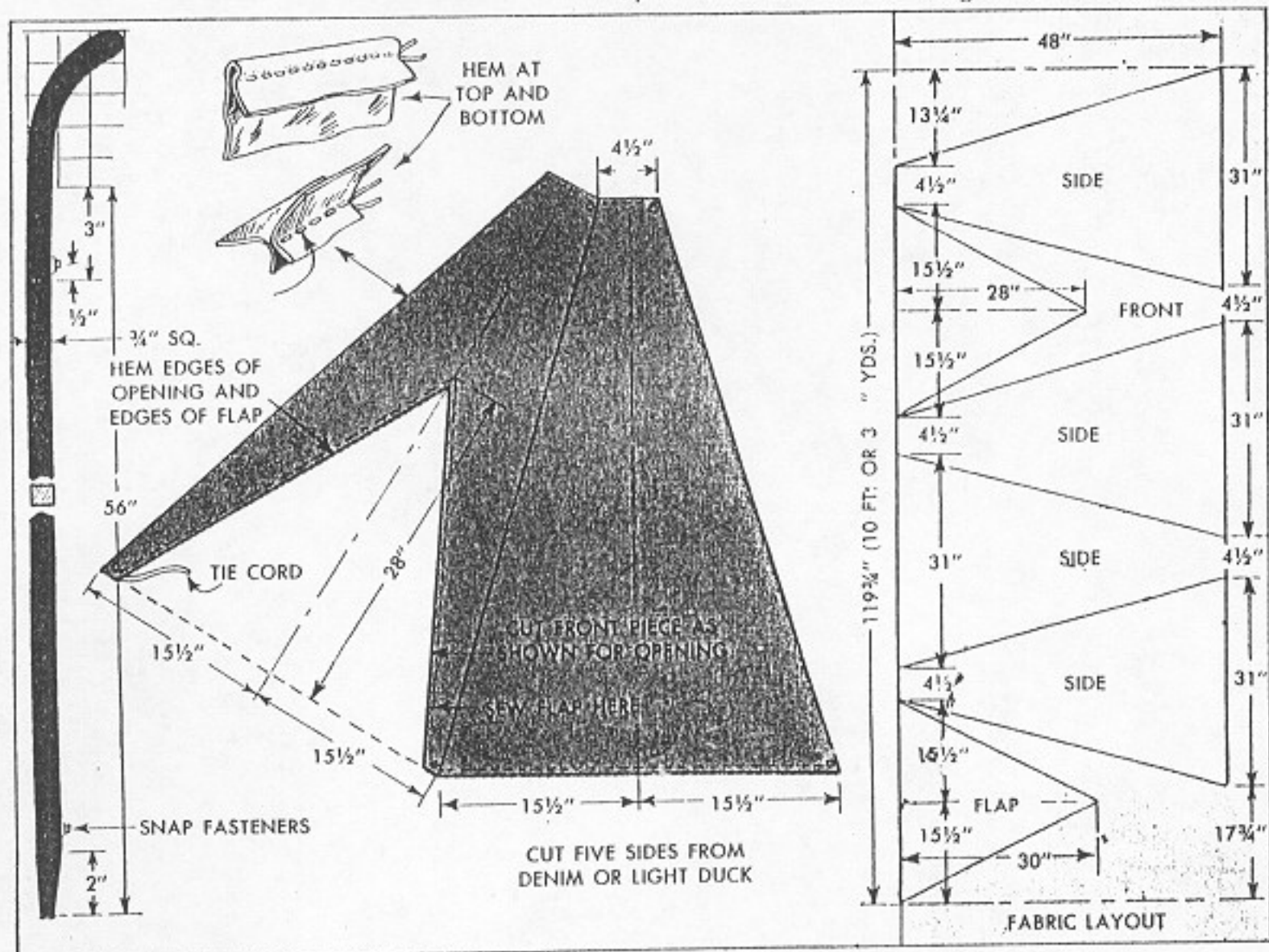


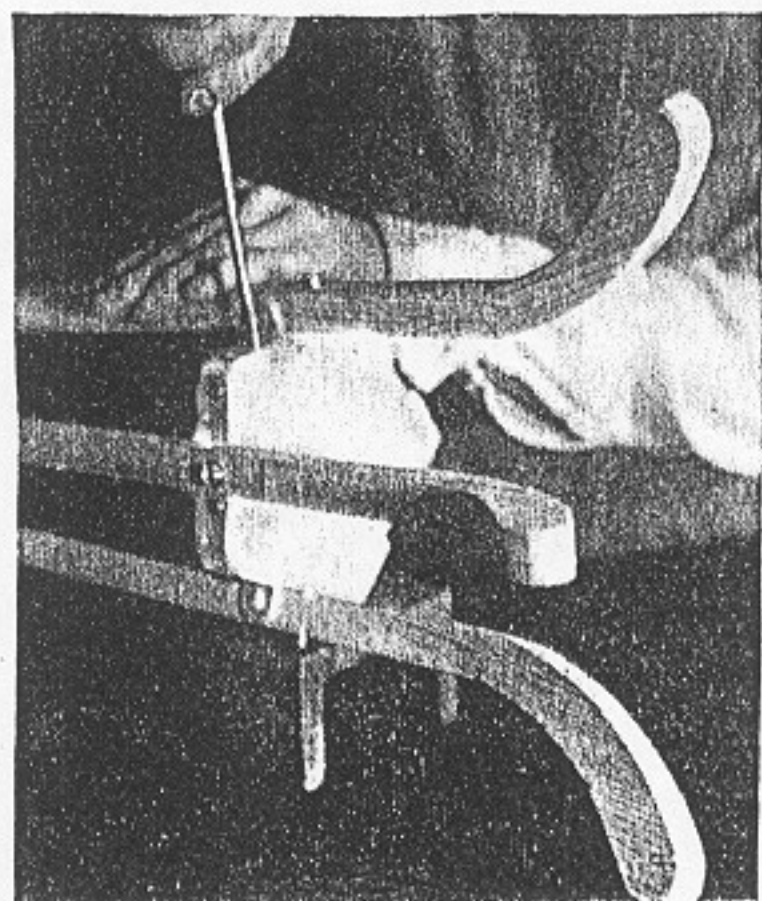
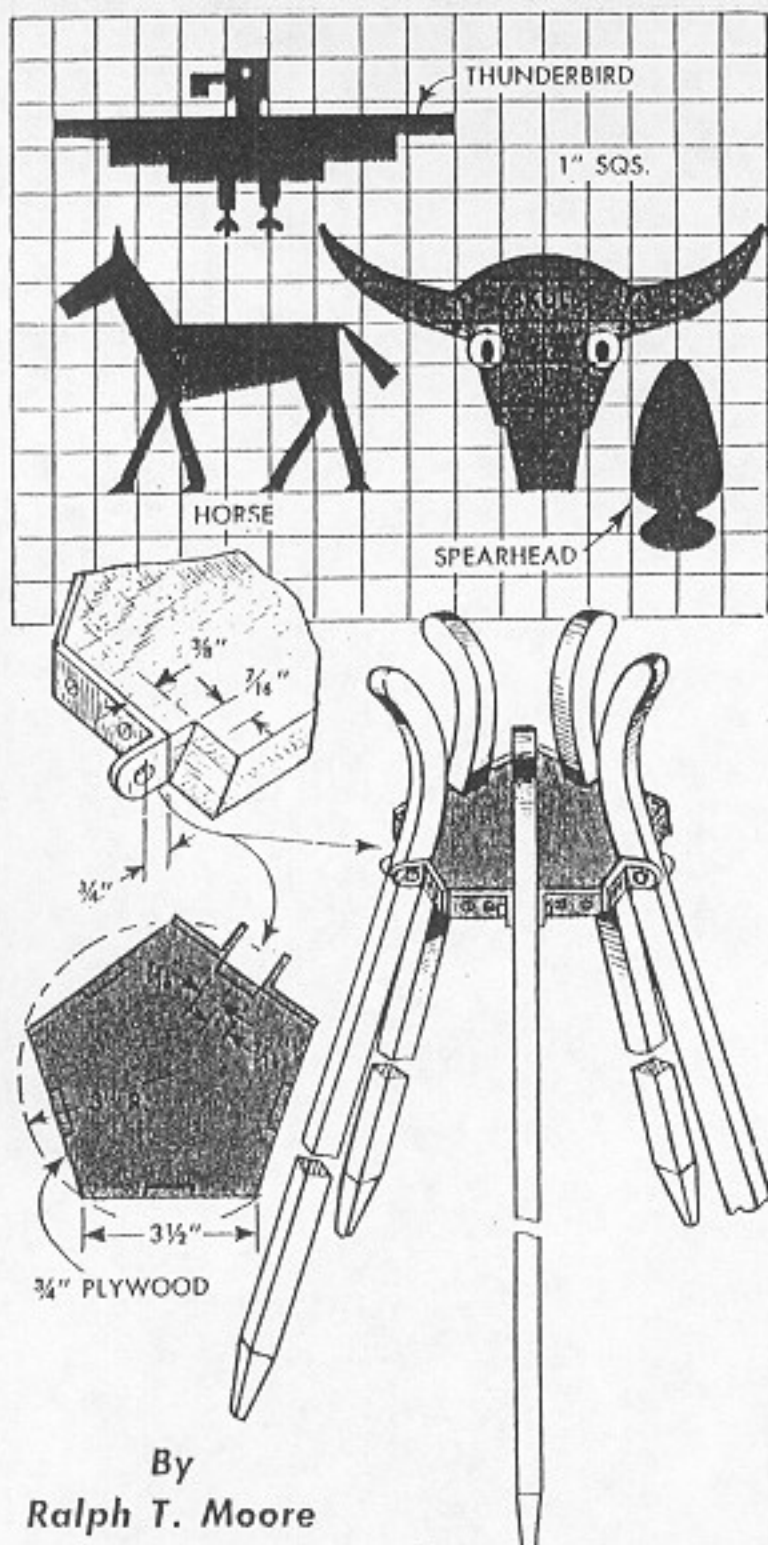
LITTLE-INJUN TEPEE

CHILDHOOD'S favorite game of cowboys and Indians can be double fun when the back-yard "reservation" has a real Indian tepee in it. The one shown here will appeal to parents, too, because it can be erected and dismantled so easily. To set up the tepee, it is only necessary to squeeze the top curved portions together. To begin construction, cut the five poles from $\frac{3}{4}$ -in. spruce or fir. Then saw the curved ends and fasten them to the tops of the poles with glue and screws. Next, prepare the pivot block from the detail next page, bending the angles from $\frac{3}{16}$ -in. aluminum or sheet metal. For the covering, you will need $3\frac{1}{2}$ yd. of heavy denim or light duck, 48 in. wide. ★ ★ ★



Popular Mechanics Aug. 1955





Harper's Weekly Dec. 5, 1857

A WIFE'S PRACTICAL JOKE.

Last Saturday evening a gentleman, residing at Jamaica Plain, was sitting with his wife and some friends at their parlor fire, when the door-bell was violently rung. The lady rose, but then suggested to her husband that, as the girl was out, he had better go to the front door. Accordingly, he opened it, and found no one there; but there was a nicely done up basket, covered with white linen, at his feet, and he thought he heard the rustling of a female dress departing. After looking vainly up and down the street and around the portal, he took the basket into the parlor. On the covering being removed, a beautiful little child appeared, some five months old. The lady screamed, one of the lady visitors took up the baby and found a note pinned to its dress, which charged the gentleman of the house with being the father, and implored him to support it.

A rich scene ensued between the injured wife and the indignant husband, the latter utterly denying all knowledge of the little one, and asserting his innocence. The friends interfered, and at last the wife was induced to forgive the husband, although he still stood to it like a Trojan that he had always been a faithful husband. Finally the lady very regally told her husband that it was strange he should not know his own child, for it was their mutual offspring, which had just been taken from its cradle up stairs by the nurse, for the very purpose of playing the joke; and the surprised husband finally joined in the laugh which was raised at his expense.

A NEW MAZEPPA.

One John Rules, of Springfield, Illinois, came to his death in a terrible manner on September 13, near Columbia, Oregon Territory. The *Tuolumne Courier* says that he had been indulging freely, and being rather noisy, a friend volunteered to see him home. After some trouble he was mounted upon his friend's horse, and, for greater security, his legs were tied together under the horse's belly. The party then set out for Springfield, Rules's companion leading the horse. When near the lower end of Broadway the animal became restive, reared, and fell back on his rider, but immediately sprang up and galloped away like the wind. As the horse got to his feet the saddle turned with Rules, and, being fastened to the beast, at every bound his head dashed against the ground. This Mazeppa-like ride was checked at Brazee's lumberyard, upward of a quarter of a mile from the starting-point. Rules was taken from the horse dead and horribly mangled. His arm was broken in several places, and his brains mingled with the dust of the road.

LEFT HIS EYE TO WATCH NATIVES.

Popular Mechanics June, 1903

A prospector of Rhodesia, who had a glass eye, being wishful to get away for a day's shooting, hit upon an ingenious expedient for keeping his native laborers up to the mark during his absence. Knowing that they would cease work as soon as his back was turned, he called the "boys" together and told them that, although he himself would be absent all day, he should leave one of his eyes behind to see that they did their work. Much to the surprise and bewilderment of the natives, he suited the action to the word and, taking out the glass eye, placed it on the stump of a tree and walked off. For sometime the Kaffirs worked like elephants, now and then casting furtive glances at the eye to see if it was still watching them. At last one old Kaffir put down his shovel and, picking up a bucket, approached the tree stump and gently covered the eye with the bucket. As soon as the gang saw that they no longer had the boss' eye upon them they lay down and slept peacefully until sunset.



SNOWSHOES

How to Make and Use Them

By Stillman Taylor

POPULAR MECHANICS 1915

PART I—Shapes of Snowshoes

TO the inventive mind of the North American Indian we owe the snowshoe, and its conception was doubtless brought about through that prolific source of invention—necessity. The first models were crude web-footed affairs, but improvements in model and manner of filling the frames were gradually added until the perfected and graceful shoe of the present was finally reached. The first snowshoes were made by the Indians, and the Indians of Maine and Canada continue to fashion the finest models today.

The snowshoe is a necessity for the sportsman and trapper whose pleasure or business leads him out in the open during the winter season, when roads and trails are heavily blanketed by a deep fall of powdery snow. But the use of the web shoe is by no means confined to the dweller in the wilderness, since the charm of wintry wood and plain beckons many lovers of the outdoors to participate in this invigorating sport, and snowshoe tramps are fast growing in popularity in and about our cities and towns.

All the modern snowshoes are constructed upon practically the same general lines, although the types of frames differ considerably in size as well as in shape, and the filling of hide is often woven in many varied and intricate patterns. The frame or bow—usually made of ash in order to get strength with light weight—is bent in many shapes, but the one shown in the diagram is a typical general-purpose shoe, and may be called standard. The frame is held in shape by means of two wooden cross braces, neatly mortised into the frame. These braces

are spaced some 15 or 16 in. apart, and so divide the shoe into three sections, known as the toe, center, and heel. The filling is woven into a lanyard, which is a light strip of hide firmly laced to the frame through a double row of holes drilled in the wood. The center filling is woven of heavy strands of rawhide, in a fairly coarse mesh, because this part of the shoe must bear the weight of the body and the brunt of wear. The end fillers for toe and heel are woven of lighter strands of hide, and the mesh is, of course, smaller.

As may be noted by referring to the drawing, a center opening or "toe hole" is provided, and as the greater strain on the filling lies directly under the ball of the foot, the shoe is reinforced at this point by the "toe cord" running across, and the "toe-cord stays," which are tied in on each side of the toe hole—one end being fastened to the toe cord and the other lashed over the wooden cross bar of the frame. These reinforcing cords are formed of several strands of hide, the stays being again wound with finer strands.

To prevent slipping and to secure a good foothold while walking, the manner of attaching the foot to the shoe is of importance, and this is done by making use of a toe strap, which will allow the toe to push down through the toe opening as the heel of the foot is lifted in the act of walking. A second strap, or thong, leading from the top around the foot, above the curve of the heel, is needed to lend additional support in lifting the snowshoe, to effect the easy shambling stride characteristic of the snowshoer.

There are, of course, a great number of models or styles, some one style being popular in one locality, while an altogether different style is preferred in another part of the country. The most representative types are well shown in the illustrations, and a brief

description will point out their practical advantages, because each model possesses certain merits—one model being designed for fast traveling in the open, another better adapted for brush travel, while others are more convenient for use in a hilly country where much climbing is done, and so on.

Style A is regarded by snowshoe experts as an extreme style, for it is long and narrow. It is designed for fast traveling over smooth and level country, and over loose, powdery snow. This style is much used by the Cree Indians, and is usually made 12 in. wide by 60 in. long, with a deeply up-curved toe. It is a good shoe for cross-country work, but is somewhat difficult to manage on broken trails, when the snow is packed, and also affords rather slippery footing when crossing ice. Owing to the stout construction of the frame and reinforcement needed to retain the high, curved toe, style A is more difficult to manage than the more conservative models, and its stiffness of frame makes it more fatiguing to wear, while its use is a decided handicap in mountainous districts, because a curved toe always makes hill climbing more difficult.

Style B may be considered the ordinary eastern model, and a common style best adapted for all-around use. It is a neat and gracefully designed frame, about 12 in. wide and 42 in. long, and is usually made with a slightly upcurving toe, about 2 in. turn at the toe being correct. When made by the Indians of Maine, this model is fashioned with a rather heavy heel, which is an advantage for fast walking, while it increases the difficulty in quick turning.

Style C is a favorite model among the hunters and woodsmen of New England. This is a splendid style for general purposes in this section of the country, since the full, round toe keeps the toe up near the surface, and lets the heel cut down more than the narrow-toe models. Style C is an easy shoe to wear, and while not so fast as the long, narrow frame, its full shape is more convenient for use in the woods. It is usually made with about 1 to 1½-in. turn at the toe.

Style D is the familiar "bear's paw," a model originating with the northeastern trapper. This model is well adapted for short tramps in the brush, and having a flat toe, is likewise a good shoe for mountain climbing. For tramping about in thick brush, a short, full shoe enables one to take a shorter stride and turn more quickly, but it is a slow shoe for straight-ahead

traveling.

When purchasing a pair of snowshoes, some few important considerations should be kept in mind, and the size and model will depend upon the man to some extent, since a large, heavy man will require a larger snowshoe than would suffice for a person of lighter weight. Height also enters into the choice, and while a small person can travel faster and with less fatigue when equipped with a proportionately small shoe, a tall man will naturally pick out a larger-sized snowshoe for his use. For a country where deep snows prevail, larger sizes are best, but in localities where the snow packs solidly and there is considerable ice, and in mountainous districts, or for rough-country traveling, the smaller sizes will give more satisfaction and prove more durable also. For a wet-snow locality, the center filling should be strung in rather coarse mesh, while for soft, powdery snow, a finer mesh will be the logical choice.

There are snowshoes and snowshoes, and while there are fine models regularly stocked by a few of the better sporting-goods firms, there is likewise a deal of poorly made snowshoes on the market. It is well to pay a fair price and secure a dependable handmade article, for the cheaper snowshoes—often filled with seine twine and the cheapest hide (commonly known in the trade as "gut")—will warp and twist in the frame, and the shoddy filling will soon become loosened up and "bag" after a little use. The best snowshoes that the writer is acquainted with are made by the Indians, and the filling is ordinarily made of neat's hide; cowhide for the center filling, and calfskin for the toe and heel. A first-class pair of snowshoes may be had for about \$6 to \$7.50, and when possible to do so, it is best to have them made to order. This plan is, of course, necessary in case one wishes to incorporate any little wrinkles of his own into their making, or desires a flatter toe, lighter heel, or a different mesh

A Snowball Thrower

By ALBERT BATES, JR.
POPULAR MECHANICS 1915



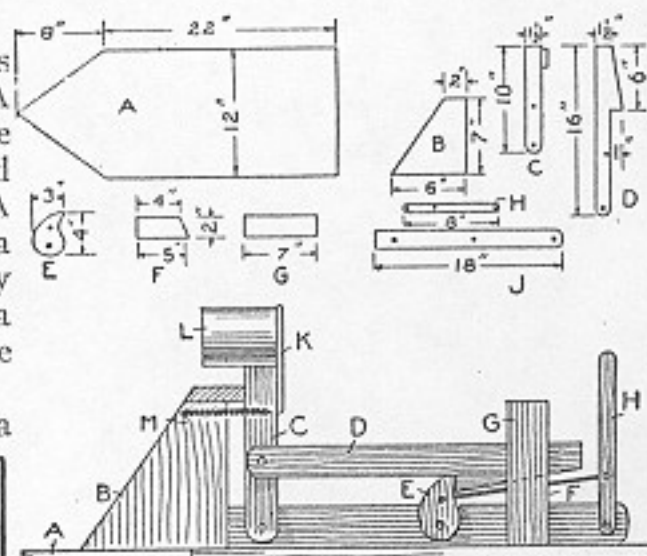
Cannonading a Snow Fort with the Use of a Snowball Thrower

The snow fort with its infantry is not complete without the artillery. A set of mortars, or cannon, placed in the fort to hurl snowballs at the entrenched enemy makes the battle more real. A device to substitute the cannon or a mortar can be easily constructed by any boy, and a few of them set in a snow fort will add greatly to the interest of the conflict.

The substitute, which is called a

snowball thrower, consists of a base, A, with a standard, B, which stops the arm C, controlled by the bar D, when the trigger E is released. The tripping of the trigger is accomplished by the sloping end of D on the slanting end of the upright F. Sides, G, are fastened on the piece F, with their upper ends extending above the bar D, to prevent the latter from jumping out when it is released by the trigger.

The trigger E is tripped with the handle H, connected to the piece J, on which all the working parts are mounted. The upper end of the arm C has a piece, K, to which is attached a



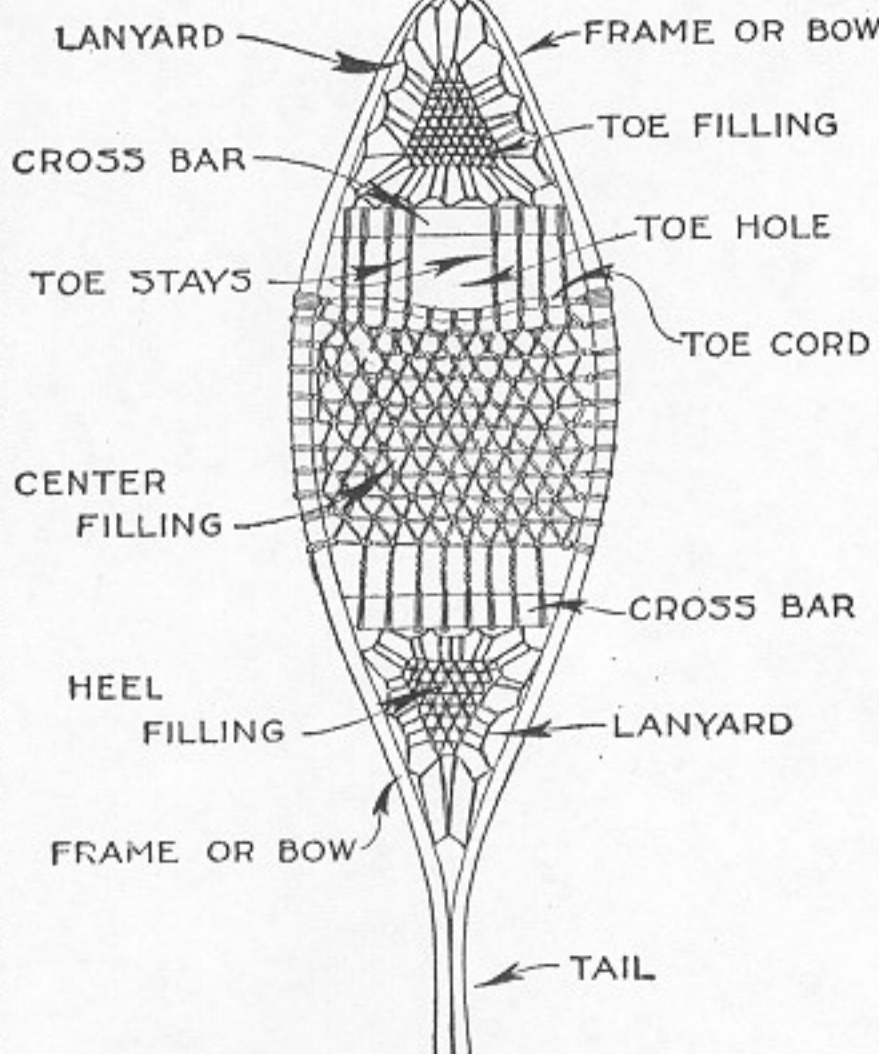
The Dimensioned Parts and the Detail of the Completed Snowball Thrower

tin can, L, for holding the snowball to be thrown. A set of door springs, M, furnishes the force to throw the snowball.

All the parts are given dimensions, and if cut properly, they will fit together to make the thrower as illustrated.

dered with the flat toe, or a turn not greater than 1 in. The frame may be in either one or two pieces, depending upon the size of the shoe and the ideas of the Indian maker, but it is well to specify white ash for the frames in the order. No Indian maker would be guilty of using screws or other metal fastenings, but many of the cheap and poorly fashioned snowshoes are fastened at the heel with screws, thus making this a decidedly weak point, since the wood is quite certain to split after a little rough service. In contrast to the poor workmanship of these low-priced snowshoes, the Indian-made article is fashioned from sound and properly seasoned wood; the cross bars are snugly fitted by mortising to the frame; the filling is tightly woven, and the heel is properly fastened by lacing with a rawhide

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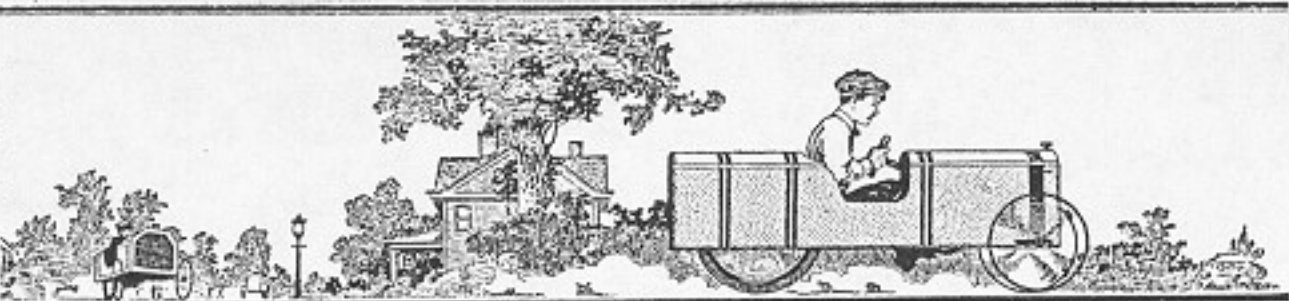


The Frame of a Snowshoe in Its Usual Construction, Showing the Crosspieces with Their Laced Fillings of Hide and the Different Parts Named, for a Ready Reference

from the usual stock models.

Where but one pair of snowshoes is purchased, style B will probably prove the best selection, and should be or-

The cyclemobile is of the three-wheeled type and can be easily constructed in the home workshop with ordinary tools. The main frame is built up of two sidepieces, AA, Fig. 1, each 2 in. thick, 4 in. wide, and 7 ft. long, joined together at the front end with a crosspiece, B, of the same material, 17 in. long. The sides are placed slightly tapering so that the rear ends are 11 in. apart at the point where they are joined together with the blocks and rear-wheel attachments.



A Cyclemobile

Popular Mechanics

1915

By FRANK PFEFFERLE



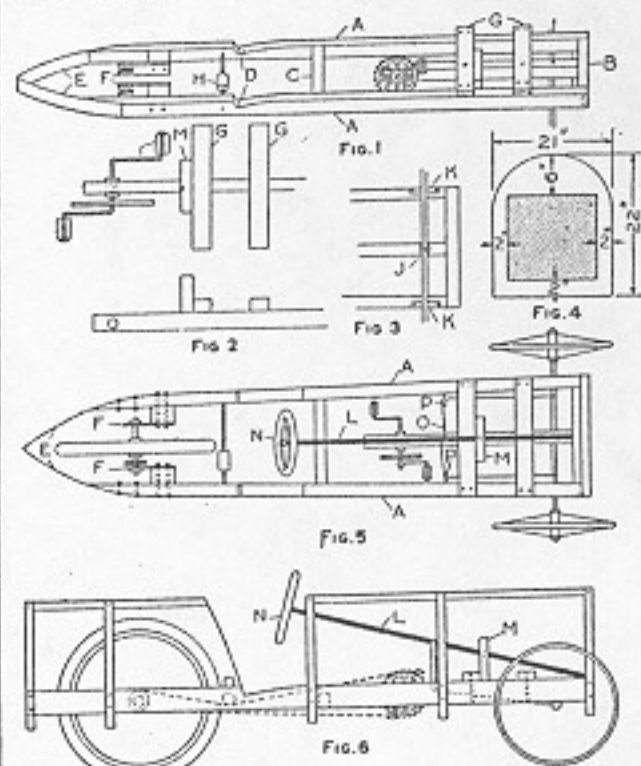
Snowshoe Experts Regard This as an Extreme Style, for It is Long and Narrow

it is a good idea to select a filling of good heavy weight and with a firmly woven and open mesh, say, about $\frac{3}{4}$ in. The toe and heel sections will, of course, be of finer-cut hide and smaller mesh, and it is wise to avoid those shoes employing seine twine for the end filling. Some factory-made snowshoes are given a coat or two of varnish, but this, while serving to make them partly waterproof, makes them rather slippery when crossing logs and ice. Most woodsmen prefer to leave both frame and filling in their natural condition.

The Indian-made snowshoe is always

A crosspiece, C, 13 in. long, is fastened in the center of the frame.

The place for the seat is cut out of each sidepiece, as shown by the notches at D, which are 2 ft. from the rear ends. Two strips of wood, E, $\frac{1}{2}$



Detail of the Parts for Constructing an Automobile-Type Foot-Power Car

in. thick, 4 in. wide, and 22 in. long, are fastened with nails to the rear ends of the sides, as shown. The rear wheel



Three-Wheeled Cyclemobile Propelled Like a Bicycle and Steered as an Automobile

is a bicycle wheel, which can be taken from an old bicycle, or a wheel may be purchased cheaply at a bicycle store. It is held in place with two pieces of strap iron, F, shaped similar to the rear forks on a bicycle, and each piece is bolted to a block of wood 3 in. thick, 4 in. wide, and 6 in. long, which is fastened to the sidepiece with the same bolts that hold the strap iron in place.

thong. However, Indian makers are likely to make the toe small and leave the wood to form a rather heavy heel. Some few woodsmen and sportsmen may prefer this model, but the majority favor a fuller toe and a lighter heel for general use, because the regulation Indian model, cutting down at toe and heel equally deep, increases the difficulty of easy traveling over soft snow, although it is a good shoe when used over broken trails.

When buying snowshoes at the store, see that the frames are stoutly and well made, and for all-around use,



This Snowshoe is Considered the Ordinary Eastern Model and One Best Adapted for All-Around Use

The blocks are located 20 in. from the rear ends of the sidepieces.

The pedal arrangement, Fig. 2, consists of an ordinary bicycle hanger, with cranks and sprocket wheel set into the end of a piece of wood, 2 in. thick, 4 in. wide and 33 in. long, at a point 4 in. from one end. The pieces GG are nailed on across the frame at the front end of the car, to hold the hanger piece in the center between the sidepieces, as shown in Fig. 1. A small pulley, H, is made to run loosely on a shaft fastened between the side-

pieces. This is used as an idler to keep the upper part of the chain below the seat.

The front axle is 30 in. long, pivoted as shown at J, Fig. 3, 6 in. from the front end of the main frame. Two small brass plates, KK, are fastened with screws on the under edge of each sidepiece, as shown, to provide a bearing for the axle. The front wheels are taken from a discarded baby carriage and are about 21 in. in diameter.

A good imitation radiator can be made by cutting a board to the dimen-

sions given in Fig. 4. A large-mesh screen is fastened to the rear side to imitate the water cells.

The steering gear L, Fig. 5, is made of a broom handle, one end of which passes through the support M and fits into a hole bored into the lower part of the imitation radiator board. A steering wheel, N, is attached to the upper end of the broom handle. The center part of a rope, O, is given a few turns around the broom handle, and the ends are passed through the openings in screweyes, PP, turned into the inner surfaces of the sidepieces AA, and tied to the front axle.

The seat is constructed of $\frac{1}{2}$ -in. lumber and is built in the notches cut in the main frame shown at D, Fig. 1. The body frame is made of lath, or other thin strips of wood, that can be bent in the shape of the radiator and nailed to the sidepieces, as shown in Fig. 6. These are braced at the top with a longitudinal strip. The frame is then covered with canvas and painted as desired.

provided with a generously large toe hole, so that ample foot covering may be used. This point is generally overlooked in the machine-made product, and the toe cords are also frequently roughly formed, thus chafing the feet and making them sore. These details may or may not prove a handicap for short tramps near town, but for long trips through the woods, they are important considerations.

The Indian manner of tying the snowshoe to the foot by means of a single twisted and knotted thong is a good method of attachment, in that, if the thong is properly ad-



The Style Illustrated Here is Splendid for General Purposes and is a Favorite among Hunters and Woodsmen



This is the Familiar "Bear's-Paw" Model, Originated by the Northeastern Trapper for Use on Short Tramps and in Brush

justed to the requisite snugness in the first place, the shoes may be quickly removed by a simple twist of the ankle. A better fastening is secured by using a fairly wide ($\frac{3}{4}$ in.) toe strap and a long thong. The toe strap is placed over the toes, immediately over the ball of the foot, and secured against slipping by weaving the ends in and out between the meshes of the filling until it reaches the frame on either side. This grips the toe strap firmly and does away with the necessity of tying a knot. A narrow thong, about 4 ft. long, is now doubled, the center placed just

Second Handle on Hoe or Rake Saves Stooping

Popular Mechanics 1919

Anyone who has used a hoe or rake for days at a time will appreciate the labor saved by the attachment for the



Much of the Tiring Labor in Using a Hoe or Rake is Overcome by This Simple Homemade Attachment

handle shown in the illustration. It is adjustable to various-sized persons by means of the holes at the front end of the horizontal piece. The two parts are each made of strips joined at the middle portions, and arranged to clamp on the handle of the hoe or rake. In hoeing around shrubs and large plants, the handle may be set to one side.

above the heel of the foot, and the ends passed under the toe cord, just outside of the toe-cord stays on each side. The thong is then brought up and across the toes, one end passing over and the other under the toe strap. Each end of the thong is now looped around the crossed thong, on either side, and then carried back over the back of the heel and knotted with a common square or reef knot. Calf-skin makes a good flexible foot binding, or a suitable strip of folded cloth or canvas may be used.

The regulation snowshoe harness, consisting of a leather stirrup for the toe and an instep and heel strap, will be found more comfortable than the thong, and when once adjusted snugly to the foot, the shoes may be quickly taken off and put on again by pushing the heel strap down, when the foot may be slipped out of the toe stirrup.

The use of heavy leather shoes is of course undesirable, and the only correct footwear for snowshoeing is a pair of high-cut moccasins, cut roomy enough to allow one or more pairs of

heavy woolen stockings to be worn. The heavy and long German socks, extending halfway to the knee, drawn on over the trouser legs, are by far the most comfortable for cold-weather wear. The feet, thus shod, will not only be warm in the coldest weather, but the free use of the toes is not interfered with. Leather shoes are cold and stiff, and the heavy soles and heels, chafing against the snowshoes, will soon ruin the filling.

PART II—Making the Shoe

[In making the snowshoe it may be necessary to refer to the previous chapter to select the style, or to locate the name of the parts used in the description.—Editor.]

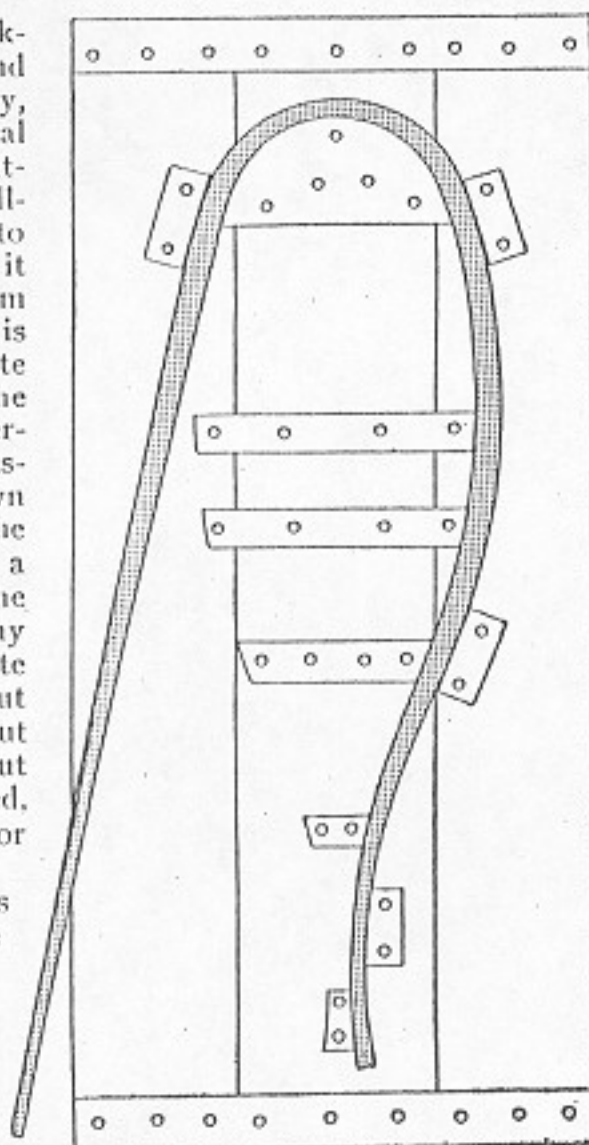
SNOWSHOE making is an art, and while few, if any, white men can equal

the Indian in weaving the intricate patterns which they prefer to employ for filling the frames, it is not very difficult to fashion a good solid frame and then fill it by making use of a simple and open system of meshing. For the frames, white ash is much the best wood, but hickory and white birch are dependable substitutes, if the former cannot be obtained. Birch is perhaps the best wood to use when the sportsman wishes to cut and split up his own wood, but as suitable material for the frames may be readily purchased for a small sum, probably the majority of the readers will elect to buy the material. Any lumber dealer will be able to supply white ash, and it is a simple matter to saw out the frames from the board. The sawed-out frame is inferior to the hand-split bow, but if good, selected material can be obtained, there will be little, if any, difference for ordinary use.

When dry and well-seasoned lumber is used, the frame may be made to the proper dimensions, but when green wood is selected, the frame must be made somewhat heavier, to allow for the usual shrinkage in seasoning. For a stout snowshoe frame, the width should be about $1\frac{1}{8}$ in.; thickness at toe, $\frac{1}{8}$ in., and thickness at heel, $\frac{3}{8}$ in. The frame should be cut 2 in. longer than the finished length desired, and in working the wood, remember that the toe of the finished frame will be the

center of the stick; the heel, the end of the stick, and the center of the shoe will lie halfway between the heel and toe.

After the frames have been finished, the dry wood must be steamed

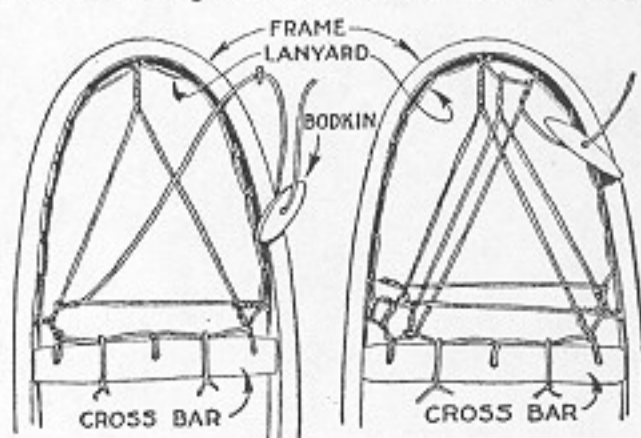


The Design of the Snowshoe is Traced on a Board, and Blocks are Used to Shape the Frame or Bow

before it can be safely bent to the required shape, and before doing this, a wooden bending form must be made. An easy way to make this form is to first draw a pattern of the model on a sheet of paper, cut out the pencil mark, and, placing this pattern on a board, carefully trace the design on the wooden form. A number of cleats, or blocks, of wood will now be needed; the inside blocks being nailed in position, but the outside stay blocks being simply provided with nails in the holes, so they may be quickly fastened in position when the steamed frame is

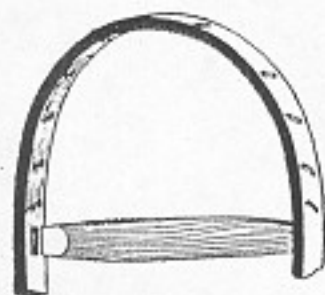
ready for the form.

To make the frame soft for bending to shape, steaming must be resorted to, and perhaps the easiest way of doing this is to provide boiling water in a



Begin Weaving the Toe Filling at the Corner of Cross Bar and Frame, Carrying It Around in a Triangle until Complete

wash boiler, place the wood over the top, and soak well by mopping with the boiling water, shifting the stick about until the fibers have become soft and pliable. After 10 or 15 minutes of the hot-water treatment, wrap the stick with cloth and bend it back and forth to render it more and more pliable, then use the hot-water treatment, and repeat the process until the wood is sufficiently soft to bend easily without splintering. The toe being the greatest curve, must be well softened before putting on the form, otherwise the fibers are likely to splinter off at this point. When the frame is well softened, place it on the bending form while hot, slowly bend it against the wooden inside blocks, and nail on the outside blocks to hold it to the proper curve. Begin with the toe, and after fastening the outside blocks to hold this end, finish one side, then bend the other half to shape. The bent frame should be allowed to dry on the form for at least a week; if removed before the wood has become thoroughly dry and has taken a permanent set, the frame will not retain its shape. The same bending form may be used for both frames, but if one is in a hurry to finish the shoes, two forms should be made, and considerable pains must be



Locate the Cross Bars by Balancing the Frame. Then Fit the Ends in Shallow Mortises

taken to make them exactly alike in every way.

When the frames are dry, secure the tail end of the frame by boring three holes about 4 in. from the end, and fasten with rawhide. The work of fitting the two cross bars may now be undertaken, and the balance of the snowshoe depends upon fitting these bars in their proper places. Before cutting the mortise, spring the two bars in the frame about 15 in. apart, and balance the shoe in the center by holding it in the hands. When the frame exactly balances, move the bars sufficiently to make the heel about 3 oz. heavier than the toe, and mark the place where the mortises are to be cut. The cross bars and mortise must be a good tight fit, and a small, sharp chisel will enable the builder to make a neat job. It is not necessary to cut the mortise very deep; $\frac{1}{4}$ in. is ample to afford a firm and snug mortised joint.

The lanyard to which the filling is woven is next put in, by boring pairs of small holes in the toe and heel sections, and lacing a narrow rawhide thong through the obliquely drilled holes. Three holes are then bored in the cross bar—one on each side about $1\frac{1}{2}$ in. from the frame, and the third in the center of the bar; the lanyard being carried through these holes in the cross bar.

Begin the toe filling first, by making an eye in one end of the thong, put the end through the lanyard loop and then through the eye, thus making a slipknot. Start to weave at the corner where the bar and frame are mortised, carry the strand up and twist it around the lanyards in the middle of the toe, then carry it down and make a like twist around the lanyard loop in the opposite corner. The thong is now looped around the next lanyard (No. 2 from the cross-bar lanyard) and fastened with the twisted loop knot illustrated. Continue the strand across the width of toe space and make a similar loop knot on No. 2 lanyard on the starting side, twist it around the strand first made and loop it under the next cross-bar lanyard loop, then carry it up and twist it around the lanyard loop in the toe of the frame, continuing in the same manner until the last lanyard of the toe is reached, when the space is finished by making the twisted loop knot until the space is entirely filled. It is a difficult matter to describe by text, but the illustrations will point out the correct way, and show the manner of making an endless thong by eye-splicing, as well as illustrating the wooden bodkin or needle used in pulling the woven strands taut. This bodkin is

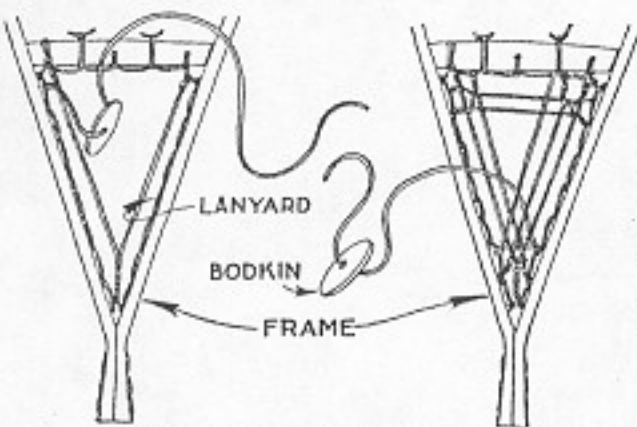
easily made from a small piece of wood, about $\frac{1}{4}$ in. thick, and about 2 in. long.



An Endless Thong is Made with Eyes Cut in the Ends of the Leather, and Each Part is Run through the Eye of the Other

To simplify matters, the heel may be filled in the same manner as the toe.

For the center, which must be woven strong and tight, a heavier strand of hide must be used. Begin with the toe cord first, and to make this amply strong, carry the strand across the frame five or six times, finishing with a half-hitch knot, as shown, then carry



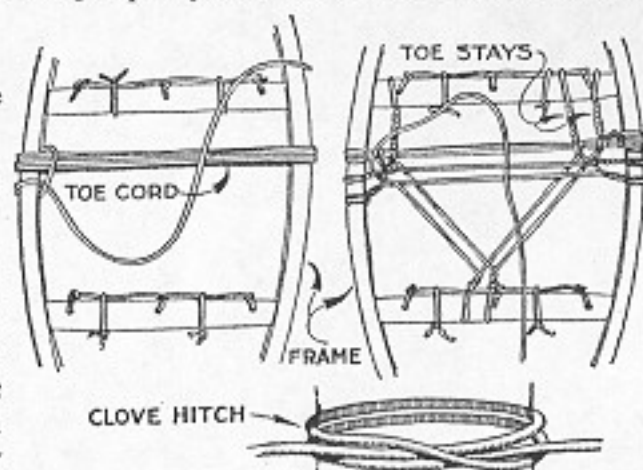
The Heel Filling is Woven by Making the Connection with the Lanyard in the Same Manner as for the Toe Filling

it up and twist it around the cross bar to form the first toe-cord stay.

As may be noted, the center section is filled by looping back and twisting the strands as when filling the toe. However, the filling is looped around the frame instead of a lanyard, and a clove hitch is used. A toe hole, 4 in. wide, must be provided for, and when enough of the filling has been woven in to make this opening, the thong is no longer looped around the cross bar, but woven through the toe cord. As the filling ends in the toe cord, it should be woven in and out at this point several times, finishing the toe hole by looping a strand around the cross bar at the side of the toe hole, then passing it down the toe-cord stay by twisting around it; then twisted around the toe cord along the filling to the other side of the toe hole, where it is twisted around the toe-cord stay on the opposite side, looped around the frame and ended in a clove hitch.

At the first reading, it will doubtless appear difficult, but a careful examination of the illustrations will soon show how the trick is done, and indeed it is really a very simple matter, being one of those things which are easier to do than it is to tell how to do them. The method of filling has been purposely made simple, but the majority of shoes are filled in practically the same manner, which answers quite as well as the more intricate Indian design.

The knack of using the snowshoe is quickly mastered, providing the shoes are properly attached, to allow the toe



The Center must be Woven Strong and Tight, and for This Reason a Heavier Strand of Hide must be Used

ample freedom to work down through the toe hole as each foot is lifted. The shoe is, of course, not actually lifted in the air, but rather slid along the surface, half the width of one shoe covering the other when it is lifted in the act of walking. At first the novice may be inclined to think snowshoes a bit cumbersome and unwieldy, and doubt his ability to penetrate the brush. However, as the snowshoer becomes accustomed to their use, he will experience little if any difficulty in traveling where he wills. When making a trail in a more or less open country, it is a good plan to blaze it thoroughly, thus enabling one to return over the same trail, in case a fall of snow should occur in the meantime, or drifting snow fill up and obliterate the trail first made. When the trail is first broken by traveling over it once by snowshoe, the snow is packed well and forms a solid foundation, and even should a heavy fall of snow cover it, the blaze marks on tree and bush will point out the trail, which will afford faster and easier traveling than breaking a new trail each time one journeys in the same direction.

A well-made pair of snowshoes will stand a couple of seasons' hard use, or last for a year or two longer for general wear. To keep them in good shape, they should be dried out after use, although it is never advisable to place them close to a hot fire, or the hide filling will be injured. Jumping puts severe strain on the frame of the shoe, and while damage may not occur when so used in deep, soft snow, it is well to avoid the possibility of breakage. Accidents will now and then happen, to be sure, and as a thong may snap at some unexpected moment, keep a strand or two of rawhide on hand, to meet this emergency.

THE TRUTH ABOUT RUSH LIMBAUGH

by Kurt Saxon

Many have suggested that I listen to Rush Limbaugh's radio show. He's also on TV. Rush really knows what's happening and has the solutions to all the world's problems; according to Rush, that is.

Rush has lots of information. He has all the facts, statistics and documentation at hand. He's very good and he may be the best. But he's not original. In 1964-'65, while a member of the John Birch Society I knew many Rush Limbaughs. They were just as up on current events and knew where all the bodies were buried. There wasn't a scheme or a scam on the Left that those Birchers didn't know about and couldn't second-guess.

But with the Communist menace about to overwhelm us, the only action members could take was to engage in peaceful protest. We were to write our congressmen; those of us who could write and to those congressmen who could read. We also wrote to and even phoned various TV stations to tell them a previous program had been leftist. And after nearly thirty years, sure enough, the Communist Empire collapsed!

Today a different enemy but the same style. A familiarity with every fear haunting anyone with a job. Studied. Polished. That's Rush.

At one time he was a radio disc jockey. I suppose that was his foot in the door and he became some sort of commentator while he practiced and perfected his act. His act was to be the voice of anyone slightly right of center politically.

So Rush mastered telling Conservatives what they want to hear. A problem I've noticed is that he has a hard time agreeing with everything in the Conservative platform. Like any other group, Conservatives believe all sorts of things and so differ on many points. But Rush must agree with every point so as not to lose one faction or another. So when he's agreeing

with an idea he doesn't agree with, it shows.

His stock in trade is hope. That's all he gives his audience and it's false hope, which prevents action on an individual's behalf. He concentrates on national problems and directs his comments to those locked into the system. If the system goes, they go with it. Most of them are unable to adapt to any sort of self-sufficient lifestyle.

They can count on Rush to assure them that their system will continue to support them with jobs, social services, and health care.

On the one hand, he does assure them. But on the other he paints a picture of almost insurmountable political and economic problems. This skillful combining of hope and terror to an audience of the individually weak is the way cults are formed. So what Rush has going for him now, and growing, is simply a cult patterned on the John Birch Society. Useless to the member but quite profitable to the cult leader.

Rush's main issues are politics and economics. According to Rush, nearly every problem we face is the result of bad politics or economics, and especially the politics and economics of the Liberals and their Democratic stooges.

Many in Rush's audience are Conspiracy Theorists.

They too, believe that most problems result from bad politics and economics. But they go further with the comforting belief that the bad politics and economics are deliberate. Economic failures are engineered by bad people who want to wreck the economy and take us over.

They are indeed comforted by the idea of a great plot since a plot exposed is a plot failed.

Rush is a soft-core Conspiracy Theorist. That is, he doesn't blame our troubles on the Jews and barely touches on international plotters. But to hear him tell it,

Clinton and his gang of drug-crazed manipulators don't do anything without some evil purpose.

Of course, there are conspiracies and more conspiracies. There have been conspiracies and conspirators ever since there have been two people to conspire against a third. When I joined the John Birch Plot-of-the-Month-club, it was obvious the Communists would be in power here by 1965. Why didn't the hundreds of plots and overall conspiracies come to anything? Or is Clinton really a Commissar?

The fact is that most conspiracies are made up by people like Rush to scare the helpless into supporting them. In actuality, whatever real plots there are don't come to anything because they're stupid to begin with.

Things are indeed getting worse, not because of any conspiracies, but because people are still guided by their animal natures instead of logic. They haven't yet risen above instinct. A woman must bear children. No matter if she can't provide for them or is too ignorant to raise them properly. Bear she must, like a cat or a dog.

A male must father children. It proves he's a man. No matter if he's a genetic farce and other men must feed his children. Less and less children are Being born to mentally sound adults.

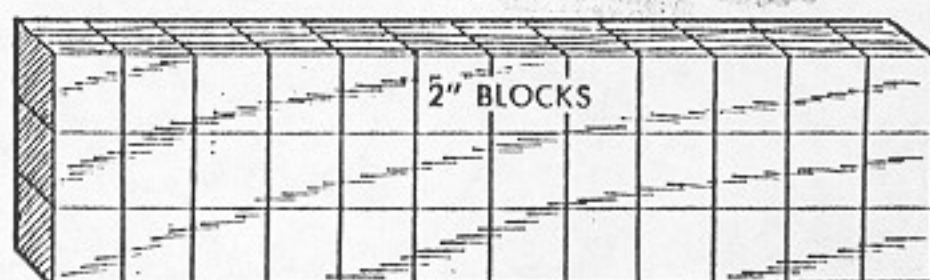
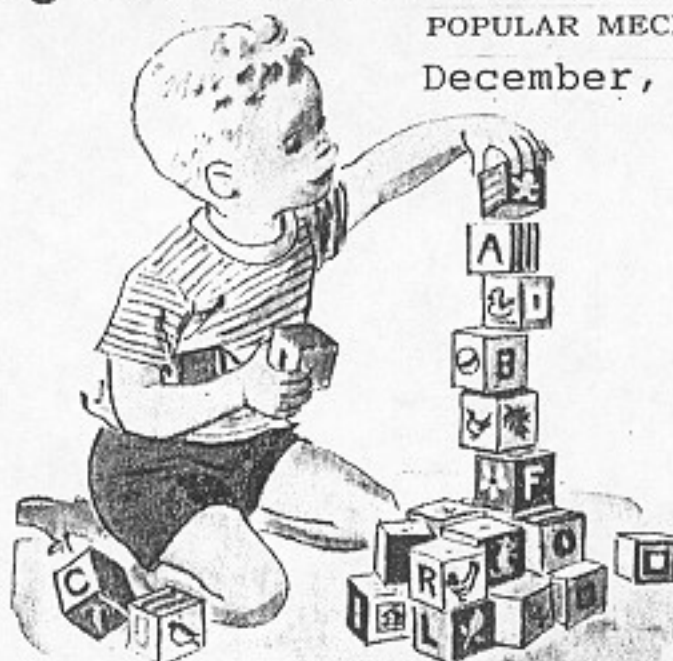
Rush sees nothing wrong in this. Surplus, suffering, degenerate children are still a market for diapers, baby foods, and little caskets. Moreover, he would force women who wish to end unwanted pregnancies to bring such pregnancies to term, even though an unwanted child is an automatically abused child.

Rush often speaks of freedom, but not for women or children. Nor does his ideas of freedom extend to the terminally ill who wish to end their suffering. Every day they can be kept alive, despite their agony, means dollars for doctors and hospitals. Whatever makes money for anyone is fine with Rush

Making Wooden Blocks for Children

POPULAR MECHANICS

December, 1950



A quick and inexpensive way to make a generous set of building blocks for your child is to cut them from a plank and then paint them to suit. Mark the plank lengthwise and crosswise to form squares of the same dimension as the thickness of the board, being sure to allow for the width of the saw cuts when laying out the squares. Rip the plank lengthwise into strips and then saw along the cross marks to form the individual blocks. After cutting, paint the blocks with a nontoxic enamel, glue appropriate numbers, decals or animal pictures clipped from magazines to the faces of the blocks and then coat with clear shellac. The latter will facilitate keeping the blocks clean and also prevent the pictures from wearing off. If the glue does not adhere to the paint, roughen the surface with sandpaper before gluing.

Warren W. Howe, Longview, Wash.

as long as it contributes to the economy.

Concerning Rush's political and economic solutions to our problems, let me run some figures by you. In 1850, for the first time in history, our species hit the one billion mark. Only 80 years later, in 1930, it doubled to two billion. Then, by 1975, only 45

years, it doubled again to four billion. Now, in 1995, it's over five and a half billion.

Our species has become a plague on the land. It threatens nearly every other species. Worse still, the lack of selection has caused downbreeding which has overrun the earth with mediocrities at best and idiots at worst. Forty-seven million American adults are functional illiterates. Twenty-eight percent of American births are illegitimate. In 1960, it was only 5%. Among blacks today, it is 60%.

America has 35 million welfare recipients and 42 million on Social Security. There are about 20 million Federal retirees. Counting prisons, nuthouses, etc., I'd say we have about 100 million social dependents out of a population of 260 million.

You've probably read that less and less workers provide for more and more social dependents. That idea isn't exactly accurate. It's misleading because the taxpayer doesn't directly support the social dependents. The government prints checks which are tacked onto the National Debt. It's the fantastic interest on the National Debt which must come from the taxpayer. That interest is the reason for the increasingly higher taxes.

To put the problem in its proper perspective, consider Germany with its 1995 population of 80 million. Imagine all the productive Americans paying for the food, clothing, housing, and health care of that whole country and more. What solution has Rush Limbaugh for that magnitude of problem?

And do you see a plot in all this? Did Clinton and his cabinet impregnate those millions of mainly retarded females on welfare? Did the Rockefellers and the Trilateralists (of which Clinton is a member) run off with all the money? Give me a break!

As for political and economic solutions, there are none. In 1980, Reagan entered office and promised a turnaround to that recession. At that time, America was the greatest lender nation. After only four years

of Reaganomics, America became the greatest debtor nation. Reaganomics was a variation of the Trickle-Down-Theory.

The idea of Trickle-Down was that tax breaks were to be given to the wealthy, who in turn would plow the savings back into their businesses. This would stimulate growth and profits, which would lead to higher wages. The workers would then spend those higher wages on industry's output and the economy would improve.

The Democrats believed in Trickle-Up. If the workers got the tax breaks, they would spend their gains on industry's output and improve the economy. Six of one and half a dozen of the other.

Rush promotes Trickle-Down, naturally, even though nothing did trickle down in the last several years. The reason for that is, the wealthy didn't plow back their tax gains into the businesses that got the breaks.

The wealthy of this generation aren't concerned with product development and improvement. Their only concern is with profit taking. Their corporate heads aren't innovative industrialists as in the past, but accountants. Also, those corporate heads are paid fantastic salaries, even as a company's losses reach into the billions.

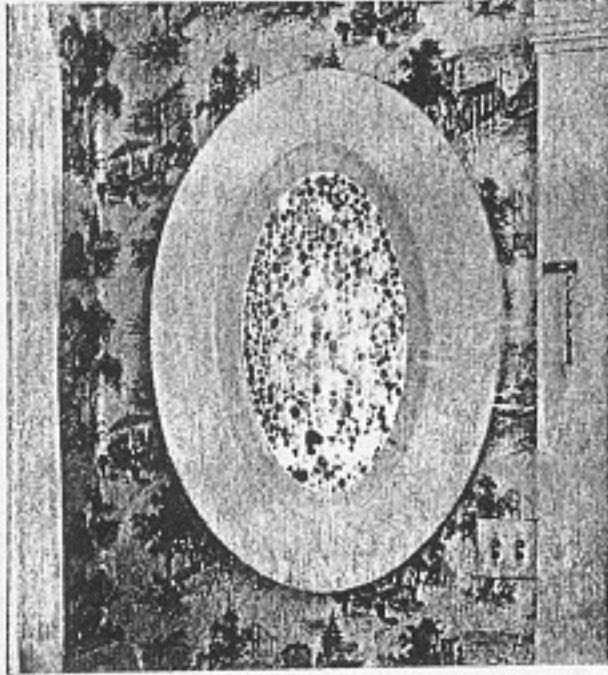
Another idiocy is diversification. Say General Motors invested millions in McDonald's. I'm not sure GM actually invests in McDonald's, but that's an example of what most them do. That really doesn't make GM and Chrysler competitive with Toyota and Nissan.

As for Democrats, Clinton is already raising taxes on the workers. Instead of giving the workers those tax breaks to prove the Trickle-Up Theory, he's slating billions to raise the standard of living of the unproductive. So both the Republicans and Democrats are incompetent and neither understands the theories they campaign on.

Clinton promised that in two years he would abolish welfare as we know it. But instead of billions in tax cuts to help the

Translucent pebble mosaic window

DARROW M. WAYT



Translucent pebble mosaic glows when daylight shines through. At night, stones reveal their surface colors, glow to outside

Sunset NOVEMBER 1961

This old-fashioned entry window was a cold, black hole in the wall at night, and conventional window coverings did not seem to suit it. The owner, an inveterate collector of beach pebbles, made this translucent pebble mosaic, using boat-laminating polyester resin as a grout.

To cull the translucent stones from his collection, he first cut a 1/2-inch hole in a piece of cardboard, and put a light under it. By placing each stone in turn over this hole to test for translucence, he sorted out enough to cover the window area.

To make a mold, he had a piece of single-strength glass cut to the size and shape of the glass area inside the window frame, and made a 1/2-inch lip by taping a strip of metal from a length of weatherstripping around the edge of the glass. Because resin will dissolve some plastic tapes, he

kept the metal as tight against the glass as possible, taping around the outside and under the glass for a good seal.

After arranging the pebbles on the glass, he mixed together the resin and catalyst (using only half the specified amount of catalyst to prevent rapid curing and possible warpage) and poured the resin flush with the top of the mold, so that at least half of each stone was embedded.

When the casting had hardened sufficiently (in about two days), he stripped away the metal sides and lifted the slab from the glass. He secured it against the window, then grouted in the small space between the slab and the inside edge of the frame with flexible white tile caulking. You can buy laminating resin from boat dealers for about \$7 a gallon. This window took a little less than a quart.

workers and middle class, there would be billions in even higher taxes to train and motivate welfare addicts.

In 1969, after an accident, I was on County Welfare, then Aid To The Totally Dependent, and then Supplemental Security Income (SSI). My only associates for three years were welfare types. As in my childhood, when we moved into the slums, and found permanent slum-dwellers and later left them there, I moved into the world of the welfare addicts and finally left them all there.

I tried to convince them that they should develop skills. But they had already developed the skill of working the Welfare racket. They had adjusted to a certain lifestyle whereby they idled away their days and partied into the night. For the most part, they were emotionally unstable, mentally defective, and bone-lazy.

Moreover, any job they might be offered or might be able to learn would pay them little more than they got from the state. Say you got \$400 a month on Welfare. You are offered a menial job paying \$500 a month. Would you give up a lifestyle of ease and freedom for what amounted to \$100 a

month? You wouldn't? Neither would I.

Besides, consider the greatest burden, the unwed mother. She may have four, eight, or even ten children by the same number of males. Almost without exception, she's unresponsive to arguments for productivity. She's already a producer. She has her own brand of self-respect, rejecting all others. She's usually mentally defective and unemployable by anyone's standards.

For this unproductive class, Clinton would tax American workers and the middle class. He doesn't understand economics. Aside from being an expert manipulator of those with like ambitions, he doesn't understand politics. He doesn't understand our system, period. Neither does Rush Limbaugh. Neither does anyone else.

What people fail to realize is that systems, economic and political, are entities, not machines. People create systems and give them life. But it takes the kind of people who gave them life to keep them alive. We all know of brilliant, ruthless, strong-willed men who've created giant companies. How come, three generations later, the heirs let the business go to pot if faced with real competition?

It doesn't have to be and doesn't always happen. But it's certainly happening today with most of our industries facing competition from stronger, younger competitors, especially the Japanese.

When it comes to political entities, most people tend to idealize their founding fathers. Ours have come down to us as noble, freedom-loving patriots. In actuality, they were ruthless and self-serving. They had a good thing going on this continent and wanted it all for themselves without sharing with the Crown or putting up with British interference.

They wanted freedom and liberty. But the freedom and liberty to do as they pleased with what they could create and produce. They had no concern for lesser folk. Only property owners could vote. An owner of ten slaves had two votes, or three if he had twenty, and so on. A slave, a black person, counted as one-tenth of a person, and not even to himself but to his owner. Women had no vote and few rights. Indians were vermin to be crowded out or exterminated. Children were the property of their fathers.

The fine words of the Constitution were mainly to get the support of the people. The Bill of Rights was the rights the founders wanted as opposed to what the British had allowed them.

Even so, the Constitution and the Bill of Rights are among the most just and perfect of any such written for any people. Also, their authors were among the strongest, most purposeful, honest and intelligent men of their time.

But no objective historian can deny that our founding fathers were only for the rights of the productive. The issue was always the productive commoner against the parasitic British aristocracy, who believed they were born with the right to be supported in idleness.

The founders of our political and economic systems created a major advance in the evolution of civilization. But it was

certainly not intended for the unproductive, the predatory, and the incompetent. Two hundred years ago, very few of the unfit survived long enough to reproduce. The village idiot scrounged for food, did odd jobs, and died young. The predatory were killed almost automatically. The stupid seldom could afford wives and their offspring usually perished.

Medical science was primitive. The average life span was about 45. The rate of infant mortality was high and childbirth was hazardous. It wasn't unusual for a man to bury three wives and a dozen children during his lifetime. So our founding fathers could not have foreseen our surplus population with the hordes of morons and criminals we have today.

They couldn't have known that in successfully throwing off the tyranny of one set of parasites, they had failed to prevent the rise of another set. The rights they fought for were the rights of the productive to keep the fruits of their labor. That was the main principle of their struggle. How odd that the unproductive, the parasitic, and the predatory quote these very heroes in demanding their rights to live at the expense of the productive.

Our founding fathers were men, not gods. They were practical, not idealistic. By the same principle of freeing the productive from the parasitic, had they foreseen our era, they would have added at least three amendments to the Constitution. One would have been to abolish slavery and return the blacks to their homeland. Another would have been that no one without obvious potential could be kept alive at public expense. A third would have been that only the productive could reproduce.

The big problem with modern politicians and economists is that they don't understand the roots of our system and operate on grade-school idealism and wishful thinking. They even take pride in denouncing the greatest product of our

founding fathers, the "Robber Baron".

The so-called robber baron was often ruthless in taking what he needed to create his fortune. The railroad tycoons, the coal men, the cattlemen, the grain merchants, the oil men. They were great! They were indeed unscrupulous, exploitive, monopolistic and greedy. They were often excessive, in keeping with our violent growth period. But they created the wealth that made our nation the greatest in history. And they were doing exactly what our founding fathers paved the way for them to do.

Calvin Coolidge said, mainly in their defense, "The business of America is business". He was a real politician who knew his true function. He was a power broker, combining the functions of business with government.

Our modern politicians and economists have turned back the clock. The arguments of the Tories in favor of British rule echo in the halls of Congress today in behalf of our own parasites.

As I listen to Rush Limbaugh, I can see that he knows little of objective history. He carries on the myth that our founding fathers were really concerned with everyone, not just their own upper class.

Their system was never perfect. It was for white men only and mainly, propertied white men. All it gave anyone else was the freedom to earn what he could and keep what he earned. that's all it was meant to do.

But Rush promotes the nonsense that our system owes a living to anyone who at one time was a working part of the system. No matter that he did only what he was paid for and got what he earned and put nothing by. In harsh reality, he's part of the surplus population.

Rush doesn't acknowledge a surplus population. In fact, he encourages the birth of even more. Any unwanted pregnancy must be brought to term, regardless of the fate of the unwanted child or the burden on our already overburdened welfare system. This,

of course, contradicts his concern for the tax payer. Rush knows this.

But contradictions don't seem to bother him. Rush denies not only the population explosion but the danger to the ozone layer, dwindling natural resources, deforestation, pollution, the Greenhouse Effect and all the other threats to the environment with an impatient shrug and gets his audience focused back on the Clinton administration. He would have his audience believe that all their problems were caused by the Democrats and more are being caused by Clinton.

Clinton was governor of Arkansas for twelve years and never caused anything. It takes a strong person to be a cause and Clinton is not strong. He won't cause anything as president.

But Clinton and his Democrats aren't causes, anyway. They are effects. An effect can't be blamed for what causes it. Fifty and more years ago, the cause for most of today's problems was addressed. Medical science was at a stage where all fertile social dependents, criminals, and the insane could have been sterilized. It was suggested and argued. But commercial interests and misplaced compassion won the day.

The self-centered Conservatives, generation after generation, seeing morons and degenerates only as a market and a cheap labor pool, allowed them to multiply and swamp the system. Those millions of non-productive and predatory are the cause. Clinton and his mob are only the effect.

Rush Limbaugh's broken-record ranting against the Democrats is simply boring. What I most object to is his disinformation. According to Rush, the individual must work hard to convince his nearest politician that Rush's solutions will save the system. He tells his audience of twenty million that the system can indeed be saved, that it's really in good shape, except for the manipulations of his main scapegoat, Clinton.

believe his assurances that their lifestyles will be secure if they only follow his economic advice and rattle the chain of this or that political hack.

I listen to his callers and realize that most of them are intelligent and successful. I hear the worry in their voices and realize he's feeding them garbage, misdirecting their efforts away from self-sufficiency and toward more trust in a doomed system.

I've never heard him discuss self-sufficiency as such. Nor have I heard him discuss anything important from the standpoint of individual effort as opposed to ineffectual group protest.

He undoubtedly has as part of his audience, some of the best of our species. If he was as free and outspoken as he boasts, he could urge this segment of his audience to learn the self-reliance of their ancestors, just in case. But he's neither free nor outspoken. His advertisers permit him to denounce the bureaucracy. This is always safe, no matter how radical it may seem.

But let him just once explain that our system is on overload and is going to sputter out and he'd be off the air in twenty four hours. Let him advise his audience to buy a Corona grain mill and otherwise direct their

efforts toward self-sufficiency and he'd be off the air just as fast. His advertisers wouldn't want his audience to realize they could do without their products.

No, friends, Rush isn't the man on the white horse. He doesn't have any practical answers. He's just another wealthy huckster with a flock of sheep to shear. His message of unified political action is just as phony and self-serving as Clinton's "We're all in this together" hypocrisy.

The main difference between Limbaugh and Clinton is that they are on opposite sides of the same coin. Neither feels threatened by what he sees in store for their respective followers. They think their wealth

This gives false hope to those who are aware enough to seek alternatives to a lifestyle they stand to lose. Rush is certainly aware. I can tell from listening to him that he has an excellent frame of reference and so must know that this Disneyland for dummies is about to close down and doom most of his "ditto heads".

His audience trusts him. They really will save them. But there will come a time, and soon, when each will wish he had a Corona grain mill.

House Numbers Painted on Curbing

It is often a difficult matter to find and read house numbers from the street, especially when driving along in an automobile. In one case, where the houses were located a considerable distance from the street, one owner painted the numbers on the street curbing in front of his house, as shown in the accompanying illustration. This was found a great improvement.



Seeds Germinated and Tested in a Magazine

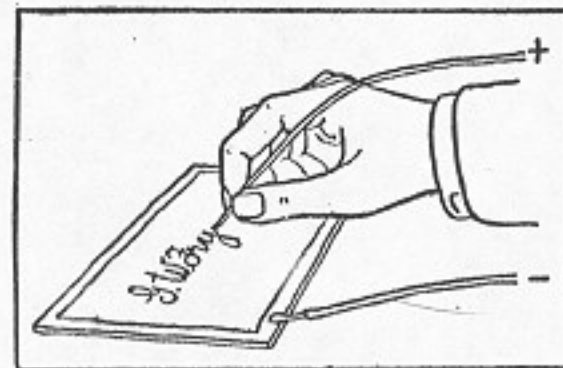
To germinate and test a number of small seeds, one may use a discarded magazine that is printed on coarse news-stock or pulp paper.



The magazine is soaked in lukewarm water and then opened for the placement of the seeds with suitable spacing between. Several pages of the magazine should separate the different layers of seeds. The magazine should be placed flat within a shallow pan and water applied from time to time to keep the pulp moist.

Writing with Electricity

Soak a piece of white paper in a solution of potassium iodide and water for about a minute and then lay it on a piece of sheet metal. Connect the sheet metal with the negative or zinc side of a battery and then, using the positive wire as a pen, write your name or other inscription on the wet paper.



Electrolytic Writing

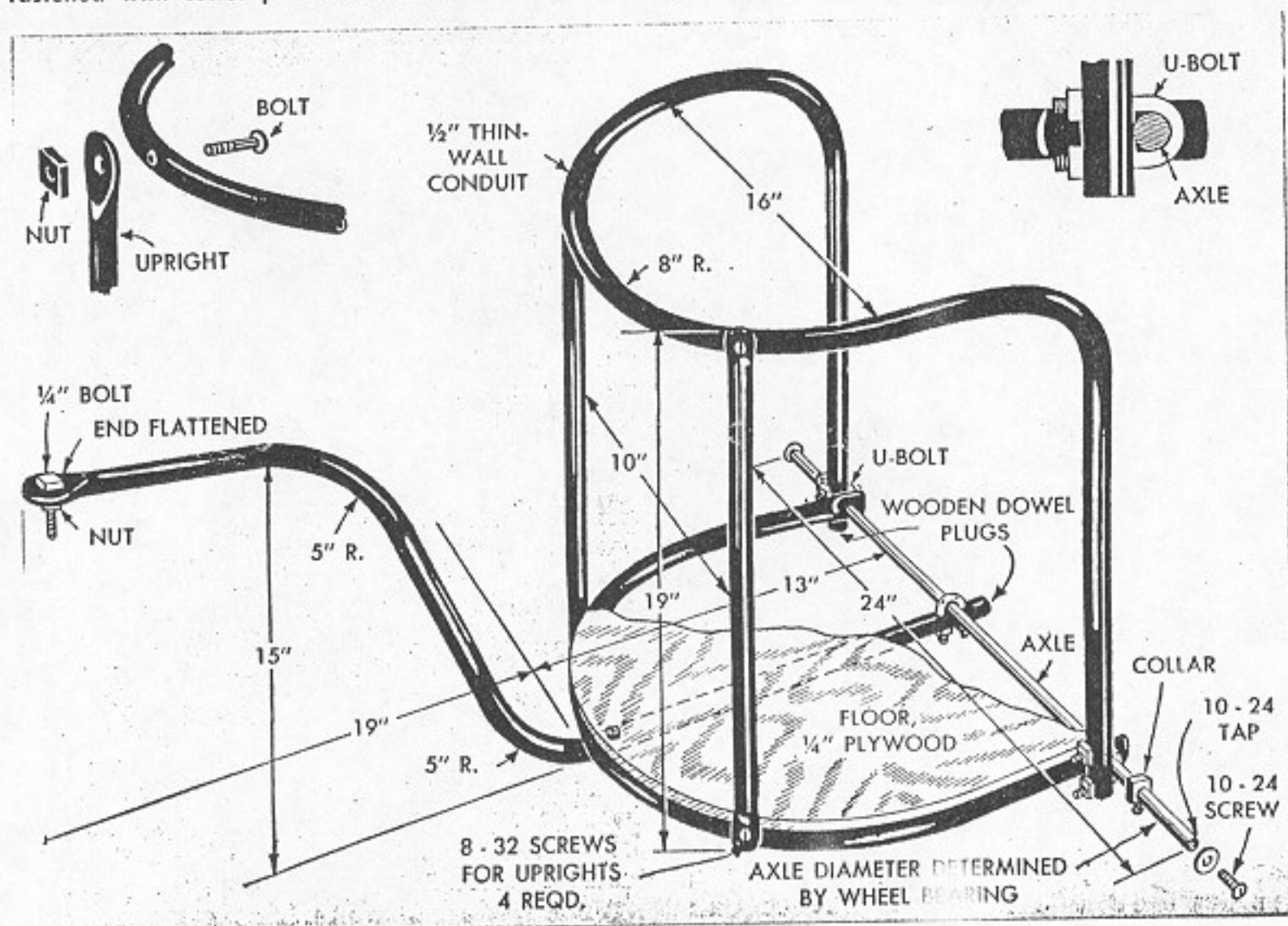
The result will be brown lines on a white background.—Contributed by Geo. W. Fry, San Jose, Cal.

Have Fun With This Chariot-Type Tricycle Trailer

POPULAR MECHANICS
DECEMBER 1950



Rolling along on semipneumatic wheels, this little trailer will double the enjoyment the youngsters get from their tricycles. The frame, rail and tongue are all bent from thin-wall conduit, either by using a standard pipe bender or by filling the conduit with sand, plugging the ends and then bending by hand. The trailer-hitch bolt engages a hole drilled in a piece of flat iron which is bolted to the tricycle-seat frame. The wheels are fastened with cotter pins or the axle is drilled and tapped for attaching them with roundheaded screws



COUNTRY STAPLES: FILLING, TASTY, NUTRITIOUS, CHEAP

by Kurt Saxon

As a small child, over fifty years ago, I loved to watch my grandma prepare food. Grandma Dodson couldn't write her name but when it came to food, she knew how to make any basic staple delicious. Her years of experience was an encyclopedia of how to turn easily available foods into delicious meals. This was a time and era of little or no money; the Great Depression. While people back in Brooklyn actually starved, ignorant hillbillies never missed a meal.

There were eggs because she had chickens. There was milk and butter because she had a cow. There was ham and bacon because she had pigs. There were beans and corn because she had a garden. She had white flour because she raised a surplus to trade at the little country store. She didn't own a can opener.

Country staples; simple, cheap, mostly home-grown have been what have kept rural folks going regardless of the overall economy. But even city people could cut their food bills by over half if they'd just learn to buy in bulk and process their own staples. It doesn't matter if you've gotten used to having all your food processed by others. Country staples are easy to prepare and so good your family will adapt to an even higher standard of eating, rather than feeling you are settling for less.

One of the most common country staples is biscuits. Grandma made them every morning. It didn't take more than five minutes of work. I remember watching her cut the biscuits with a biscuit cutter. I suggested it would be easier if, after she had the dough laid out, she should cut them in squares with a knife and eliminate the need to take up the dough around the circles and rework it. She told me she'd been doing it that way for forty years and didn't mean to change.

She put the biscuits in a baking pan and slid it into the oven of the wood stove. Then she fried the bacon and eggs and made coffee for the menfolk. Us kids had whole milk.

When the bacon and eggs were done, Grandma put some white flour into the grease and stirred it until there were no lumps. Then she poured in water and stirred until it thickened and it became gravy. I was fascinated that such a small amount of flour and grease could thicken to make such a good food. One thing I learned about gravy that I didn't like, was that if left in the pan for more than a few minutes the top of it would thicken, so it had to be used immediately.

Anyway, the biscuits were pulled open and two or three were put on the plate. Then the gravy was poured over them and salt and pepper added. A plate

of biscuits, gravy, bacon, and eggs was absolutely delicious.

You ought to learn to make biscuits and gravy for breakfast. It's quick, easy, and costs practically nothing. It's filling and along with whatever else you have, gives you everything you need to start the day.

Gravy is very easy to make. You first heat two tablespoons of bacon grease in a skillet. Then put in two tablespoons of flour and stir until there are no lumps. Now put in one cup of water, about one teaspoon of salt, a half teaspoon of pepper and stir constantly until it thickens to where it stands on its own to at least a quarter inch high. Otherwise it's just a sauce and would soak into the biscuits and just wouldn't be right somehow.

The next staple is cornbread. It's simple and easy to make, so good, so filling, and so cheap. If you grind your own with a Corona grain mill, the cornmeal costs only 6¢ a pound. Cornbread has been a southern staple for centuries.

A pan of cornbread was made for every lunch, along with pinto beans. No matter what else there was, there was always cornbread and beans. I liked to crumble a slab of cornbread and cover it with beans and thick, hot bean soup. It had the most fantastic taste. Cornbread and beans make a meal in themselves and are so cheap, they are insurance against hunger.

Cooking pinto beans is very simple. Keep them covered with simmering water until soft, up to six hours. Most recipes say to soak them overnight.

I use a Crock-Pot. I put in two cups of beans, 8 cups of water, a half pound of bacon (optional), 2 teaspoons of salt, 2 teaspoons of pepper, and cook at the highest setting for 6 hours. Anyone can do this and with a standard Crock-Pot, it's so simple there can be no errors.

Then there are corn pancakes, or griddle cakes as they are sometimes called. These are cooked like regular pancakes. The only difference in their recipe is that more water is added to make the batter as thin as regular pancake batter so it will pour. They were often made as a main supper treat.

Corn pancakes are indeed a real treat. I always spread the hot cakes with butter and put on salt and pepper. I used to make batches and pack them for lunch. They were ever so tasty and filling.

I suppose you could flood them with syrup, but I never did.

Then there are regular pancakes or plain griddle cakes. Of course, pancakes are pretty common all over the United States. But few people make pancakes from scratch anymore. However, homemade pancakes are much cheaper than commercial pancake flour. Also, they taste ever so much better than

store-bought. They have a better flavor and consistency.

The recipes below are from The Settlement Cookbook, 1927.

CORN BREAD

1 $\frac{1}{4}$ cups flour,	4 teaspoons baking powder,
$\frac{3}{4}$ cup cornmeal,	1 cup sweet milk,
$\frac{1}{2}$ teaspoon salt.	2 tablespoons butter melted,
1 egg,	

Mix the dry ingredients by sifting them together. Add the milk, the well beaten egg and the butter. Beat well and bake in a shallow pan in a hot oven, (375° F.) twenty minutes.

CORNMEAL GRIDDLE CAKES

1 cup flour,	1 $\frac{1}{2}$ teaspoons salt,
1 cup cornmeal,	2 cups milk,
1 tablespoon baking powder,	1 or 2 eggs.

Mix the dry ingredients. Beat egg well, add salt and the milk, and combine the two mixtures. A tablespoon of molasses may be added to the batter. Cook as other Griddle Cakes.

PLAIN GRIDDLE CAKES

2 teaspoons baking powder,	1 cup milk
1 cup flour,	1 egg,
$\frac{1}{4}$ teaspoon salt,	1 teaspoon melted butter.

Sift the dry ingredients. Beat the egg. Add the milk, and stir it in gradually to make a smooth batter, add melted butter or oil. If not thin enough, use more milk.

Heat an iron griddle and grease it with a piece of fat. Pour the cakes on the griddle from the end of a large spoon. When the cakes are full of bubbles, turn with a pancake turner, brown the other side. Wipe griddle with a greased cloth after each baking. The egg may be omitted.

Larger quantity: 3 cups flour, 1 $\frac{1}{2}$ tablespoons baking powder, 1 teaspoon salt, 2 cups milk, 1 egg, 2 table spoon melted butter or oil.

BAKING POWDER BISCUITS

2 cups flour,	$\frac{3}{4}$ to 1 cup milk, or water,
4 teaspoons baking powder,	2 tablespoons shortening,
1 teaspoon salt.	

Sift the dry ingredients together. Work the butter into the flour with a fork or tips of fingers. Mix the milk into the flour adding the milk gradually until as soft as can be handled easily. Put it on a floured board and roll until $\frac{1}{2}$ inch thick. Cut into rounds and bake in very hot oven (450° F.) 10 to 15 minutes. Use as little flour as possible on the board when shaping the dough.

Electricity.—Two lumps of sugar rubbed together in the dark produce distinct flashes of light, and if a lump of sugar be broken, similar phosphorescence is visible.

How to Put an Egg Into a Small Necked Bottle.—By steeping an egg in vinegar for some time it can be made pliable enough to be stuffed into a bottle. Then restore the egg to its natural shape by pouring water into the bottle.

How to Cut Glass.—Having privately dipped a thread in sulphur, wrap it round the part of the glass you wish to cut, then set fire to it, and by immersing it smartly into cold water it will immediately cut in the way required. This may cause a good deal of curiosity, and is likewise very useful on some occasions.

THE MOST DANGEROUS KIND OF COLLAPSE

by Christopher Maxwell

Many books and articles have been written and many discussions held about how to survive after the collapse of civilization. Many scenarios are presented as to what sort of event will trigger the collapse, and how long we have before the crash.

Many writers in the field, myself included, have wasted a lot of time and energy theorizing and looking for warning signals that the crash is eminent. I have finally come to the conclusion that the collapse of "Western Civilization" will be more dangerous and difficult than the sudden cataclysm we were all waiting for in the 1970's.

Today in our cities, hunting packs of savages roam the littered streets and burned-out storefronts searching for food, women, and anything they can steal or anyone they can attack. Tribes of these looters live in abandoned, boarded up buildings without heat, running water, or electricity.

Does any of this sound familiar? Of course it does. It sounds just like all those novels about life after the end of civilization as we know it. CIVILIZATION AS WE KNEW IT ENDED TWENTY-FIVE YEARS AGO!

The problem is that civilization did not end everywhere at once. We have all heard the saying "Rome wasn't built in a day". Many of us never considered the other side of that; "Rome didn't fall in a day". Many history books list 476 A.D. as the date of the fall of the Roman Empire, because that was the year that the city of Rome fell to barbarians for good. In fact, Roman civilization had been declining and devolving into the feudal system for centuries. Most of the residents of the former Roman Empire were living lives of savagery and brutal oppression long before 476.

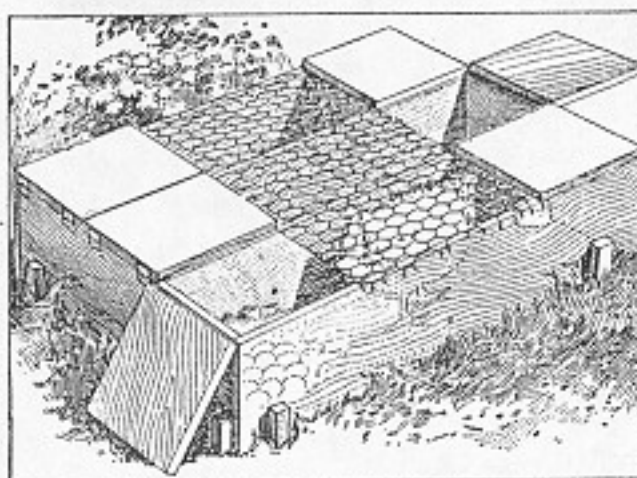
There were attempts by both the Eastern and Western Empires to reform and restore the Empire and re-establish Roman civilization. Some of these did temporarily reverse the decline and even push the barbarians back from territories they had occupied. Despite the hope generated by these restorations, none of them lasted longer than the life of one Emperor or General. The ruling classes and the masses were too degenerate to continue the work after the man who started it passed on.

Our own country is degenerating into a socialist police state. Some years it moves faster than other years. Some places are declining faster than other places. This process is much more dangerous than the sudden crash many of us were expecting. Yes, a crash would have been terrible, but then the survivors could have gotten on with the process of rebuild-

Popular Mechanics, 1919

Coop for Sitting Hens

When several hens are to hatch out settings at the same time, considerable space can be saved and much convenience afforded by making a coop as shown in the illustration. It consists of an outer frame of boards, 1 ft. wide and 6 ft. long, or as long as desired for the runway. The frame is divided into compartments by boards extending from end to end, each compartment being for one hen. The frame is placed on level ground and staked in



Each Hen Has a Compartment, with Plenty of Space for Exercising

place. At opposite ends of each compartment is a hinged cover. The intervening space is covered with wire netting, with shelter boards placed loosely over it. Under one of the hinged covers the nest should be placed on the ground, and at the opposite end food and water are provided. Each hen has plenty of space to exercise in, and must at least get up for food and water. The individual covers permit separate examination of the eggs, or feeding of the hens.

ing. If we continue on this incremental decline into a banana republic, the collapse of Western Civilization could take the rest of your life.

The dangers of this are illustrated today in the Union of Former Soviet Socialist Republics. Communism lasted long enough that there is no one left alive who remembers how to do things any other way. It would be funny watching them ask the U.S. Government how to start a free market economy, if the U.S. Government knew the answers!

The decline of our civilization may take long enough that there won't be enough people left who remember how things can be done and can start over.

Our civilization is degenerating and decaying right before our eyes. It's degenerating at different speeds in different locations, so some places remain civilized after others have turned to barbarism. Millions of people keep going to work and making their car payments and their mortgage payments. Some small towns and rural areas will remain civilized long after the last cities and suburbs have become uninhabitable by decent people.

Government remains, in fact it grows at a faster pace than ever. Unfortunately, government at all levels is in the hands of those who are bringing this civilization down, not those who are trying to save it.

After the recent rioting in Chicago, the Chief of Police informed the citizens of that city that the scum who went out looting and burning "are not the enemy". Not his enemy, maybe.

In fact, our present penalties are no threat to the criminal rabble who terrorize our society. "Civil" seizures, fines, legal expenses, and even jail time are no threat to the worthless scum who produce nothing and therefore have nothing to lose. The law, and the penalties for breaking the law, are only a threat to those who have worked, produced, accumulated some possessions, and therefore have something to lose.

The only thing that will deter the mindless criminal scum of today is fear of imminent death, and we have a government that sends troops into a riot with

unloaded rifles.

There will be occasional attempts at reform, but even if they succeed temporarily or locally, the long term trend will not be reversed. The election of Ronald Reagan in 1980 is a good example of this. Reagan could never get our degenerate Congress to stop spending more and more money every year and couldn't get our degenerate electorate to vote out their degenerate Congressmen.

The same voters who elected Reagan because he said he was going to stop the government from giving the taxpayers money away screamed when they found out he meant to cut off their government money, too.

Those of us who expected an economic collapse before the Reagan Postponement never suspected that the U.S. Government could borrow \$3 trillion in ten years. I still find it difficult to believe that people will loan the U.S. Government money. It's like loaning money to a retarded crack addict. The only way he can pay it back is to rob you first.

Of course, our degenerate bankers and financiers, like the rest of this society, all think the government will rob somebody else.

The fact that civilization is crashing gradually leads some to think it isn't crashing at all. These are the people who will not be ready when the barbarians show up at their door. These are the people who will expect the government to save them when disaster strikes.

For those who are preparing for the worst, there are a few complications in this situation that were not in your survival plans. For one thing, it means you will have to forget that idea about raiding the National Guard Armory and digging in .50 caliber Brownings around your house. It wouldn't be a good idea to attract that much attention. You are still subject to the laws because you have something to lose.

You will just have to regard the police as a larger, more organized band of marauding looters who will

leave you alone only as long as they are unaware of your existence. If you are openly armed during a riot or disaster, the police are likely to disarm you even though they can't protect you.

For example, I'm writing this on a computer, because I can write four times as much and turn out better quality writing. But I have a manual typewriter and a filing cabinet.

The good news is that the oil companies and electric and other utilities are still operating, too. The fact that telephones, electricity, gas, and running water are still available most of the time makes life a little easier and makes more preparations possible. Using these amenities to save time and get more work done is OK, as long as you are not dependent on them for the future.

The fact that civilization is decaying slowly makes it possible for me to return to the city for a year to raise some more money. This is a calculated risk, that the additional money will improve my chances by more than enough to compensate for the fact that I won't get out of the city if a serious emergency happens while I'm here.

The biggest difference between the slow decay we are experiencing and the sudden crash many expected will be the survival of government.

Many of the most dangerous non-natural disasters can only be caused by government; riots, police strikes, hyper-inflation, terrorism, failures of over-centralized monopoly power systems, nuclear accidents or nuclear war.

Nuclear power and many other monopoly businesses could only exist with government support and protection. These government supported monopolies are the cause of some of the most dangerous potential disasters in the world today.

Government is also the biggest obstacle in making realistic plans to survive these disasters. Government will try to prevent you from buying the chemicals, medical supplies, weapons, and many other items you might need unless you want to take the risk and the extra expense of violating the laws.

You may not be able to afford the land you want to buy because government takes over 40% of your earnings away from you to support system-dependent people. These very same system-dependent people will be one of the biggest dangers in the aftermath of any disaster.

Just as the forces of the law cannot protect you but try to prevent you from protecting yourself, Government cannot prevent the collapse of civilization, but will be around to try to prevent you from surviving it.

A Broomstick Horse

Popular Homecraft

JANUARY-FEBRUARY, 1939

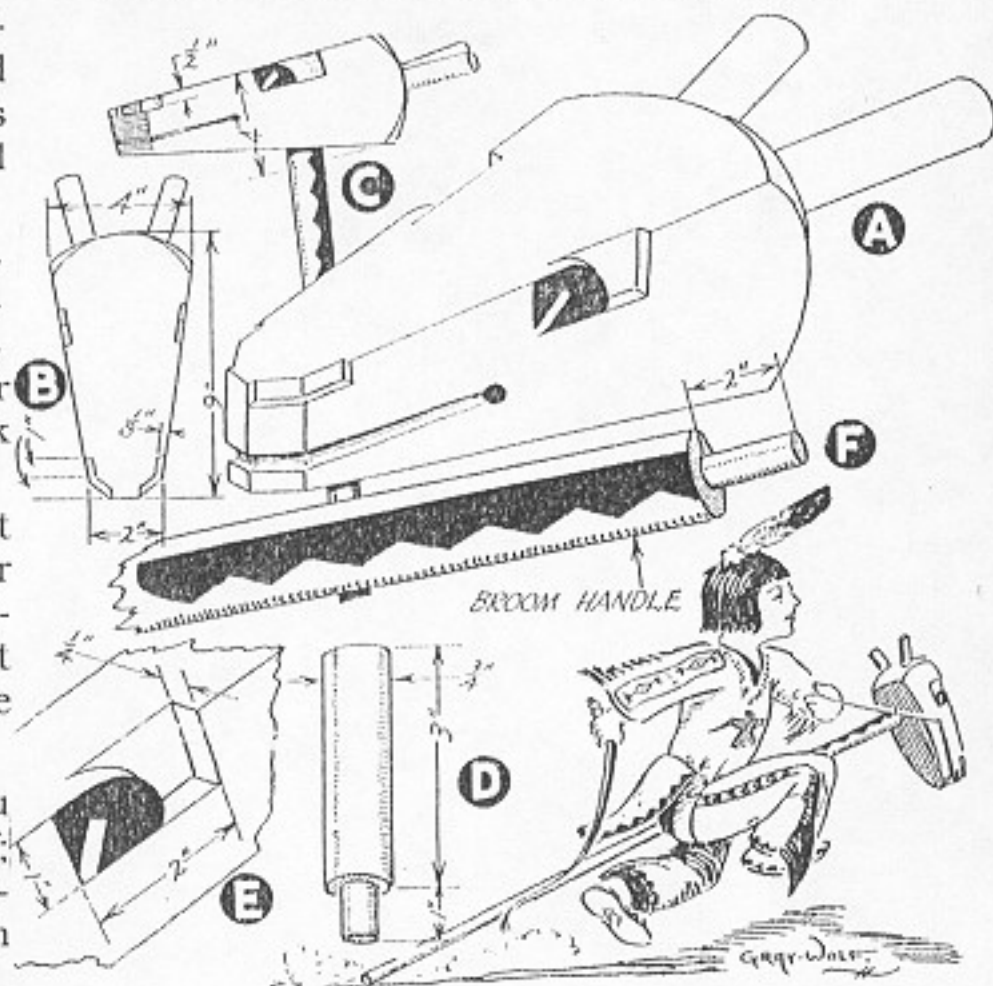
GRAY WOLF

FOR a fast ride across the open prairie, this broomstick horse will please your younger brother, and it is really no trick at all to make this bronco. The head is sawed from a wood block and is rounded at the top and then drilled for two dowels, Fig. D, which serve as ears.

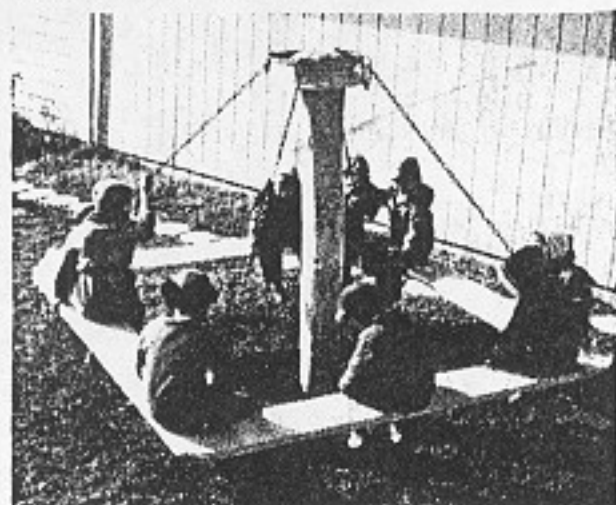
Nostrils are made by cutting recesses in the upper edges of the nose and the mouth is a groove around the end and the sides, while the eyes are made as shown in the detail, Fig. E, which also shows the dimensions.

The complete head is shown in Fig. A and the two views, Figures B and C give the sizes as well as the shape of the head.

The body, Fig. F, is a broom handle drilled to fit into the head as in C. Paint the horse any color and the mane shown in Fig. F, black. For a realistic touch, paint the mouth and nostrils red and the eyes black and white. A cord or a narrow leather strap passed through the hole drilled through the head at the end of the mouth, will make a dandy bridle.



"PINTO"



One child or nine, balanced load or not, can ride this free-spinning whirl-around. They push with their feet to make it go

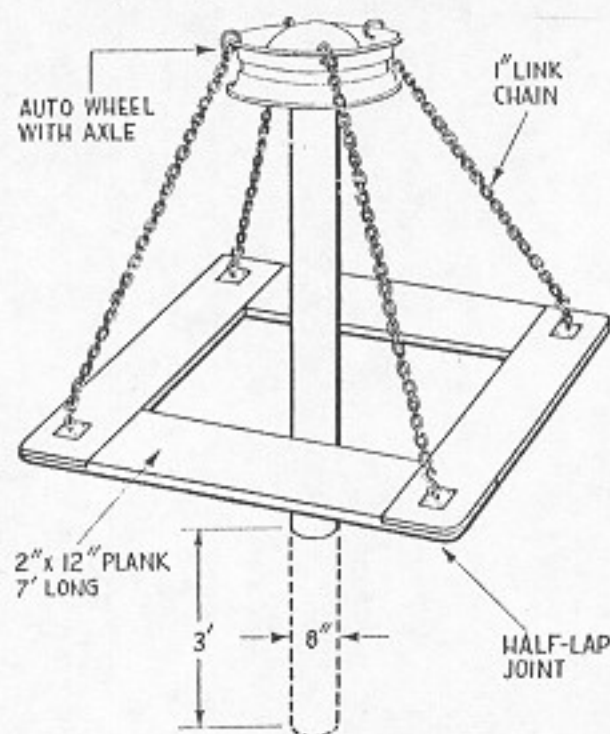
Whirl-around swing

Sunset OCTOBER 1960

This whirling swing has proved to be the big attraction in the yard of Jerre P. Buckley, Everett, Washington, who built it for his youngsters and their friends.

Automobile wheel bearings make it spin easily, go fast, and coast a long time.

He first set an 8-inch cedar pole securely in the ground. On its top, he bolted the short spindle axle of an automobile front wheel assembly (bolt the axle or its brake back plate, removing brake shoes). He drilled four holes, spaced at equal intervals around the wheel rim (for attaching the chains with heavy rings) and placed wheel on the axle, complete with hub cap to keep the joint dry and free-turning.

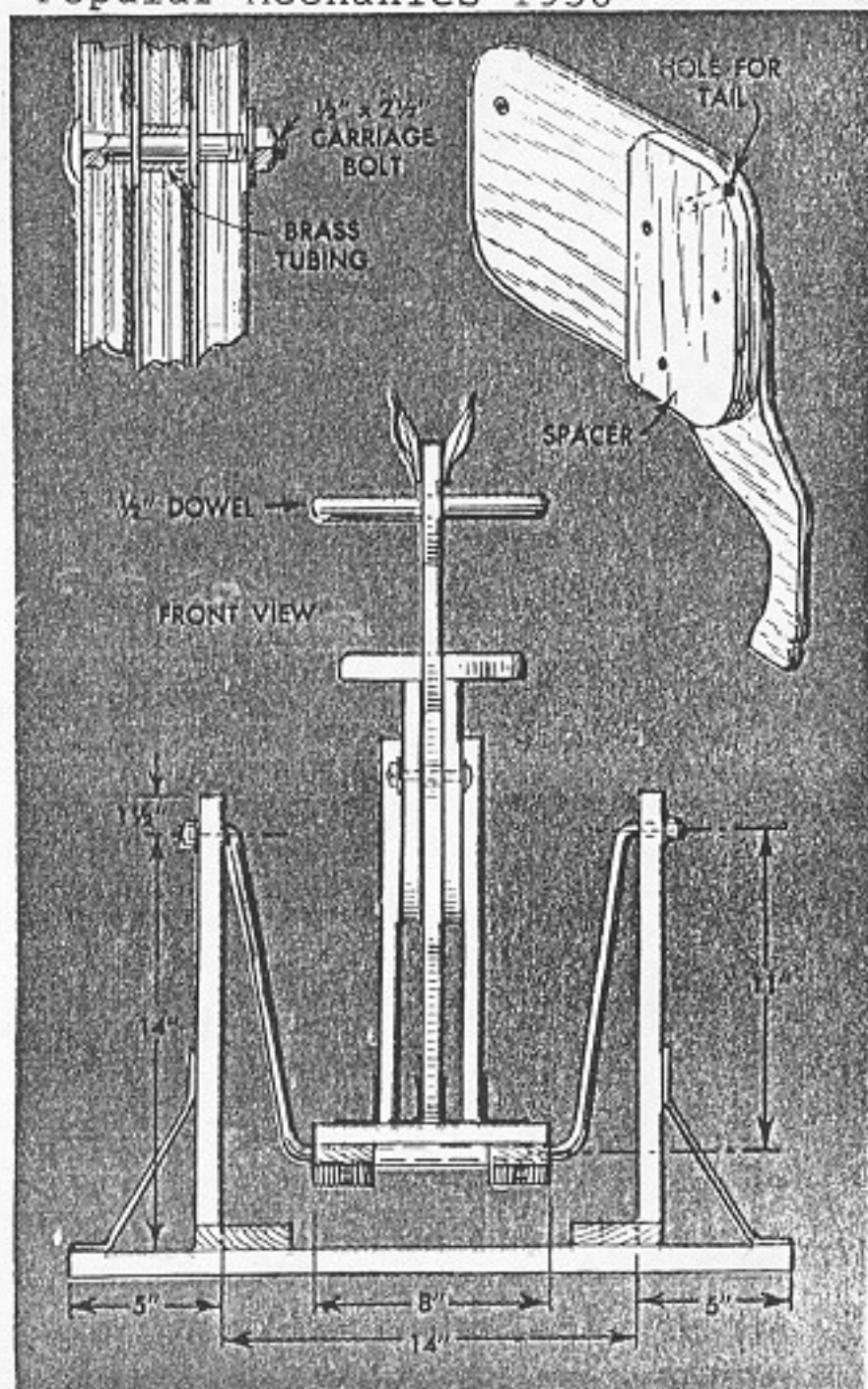


Four half-lapped 2 by 12's give the square seat, are joined together with bolts. The chains attach to the seats by heavy hammock wall plates. Adjust the chains to have seat about 12 inches above ground

HERE IS A sturdy rocking horse designed for the enjoyment of any lively youngster four to seven years of age. The base on which the horse is mounted is made of 1-in. pine lumber nailed together and reinforced with steel braces bent from $\frac{1}{8}$ x $\frac{3}{4}$ -in. stock. The parts for the horse are scrollsawed from $\frac{1}{2}$ -in. plywood, the head and foreleg being in one piece, while the hind legs and body are cut in pairs according to the squared pattern shown for each.

After assembling the horse and base, the hoofs are fastened to small wooden platforms with inside corner plates and the entire unit then is clamped to two U-shaped rods by wooden blocks notched to fit over the rods and screwed to the platforms as shown in one of the details. A length of brass tubing slipped on each of the rods before bending serves as a bearing, permitting a rocking motion when the rider pushes forward on the dowel handle bars

Popular Mechanics 1958

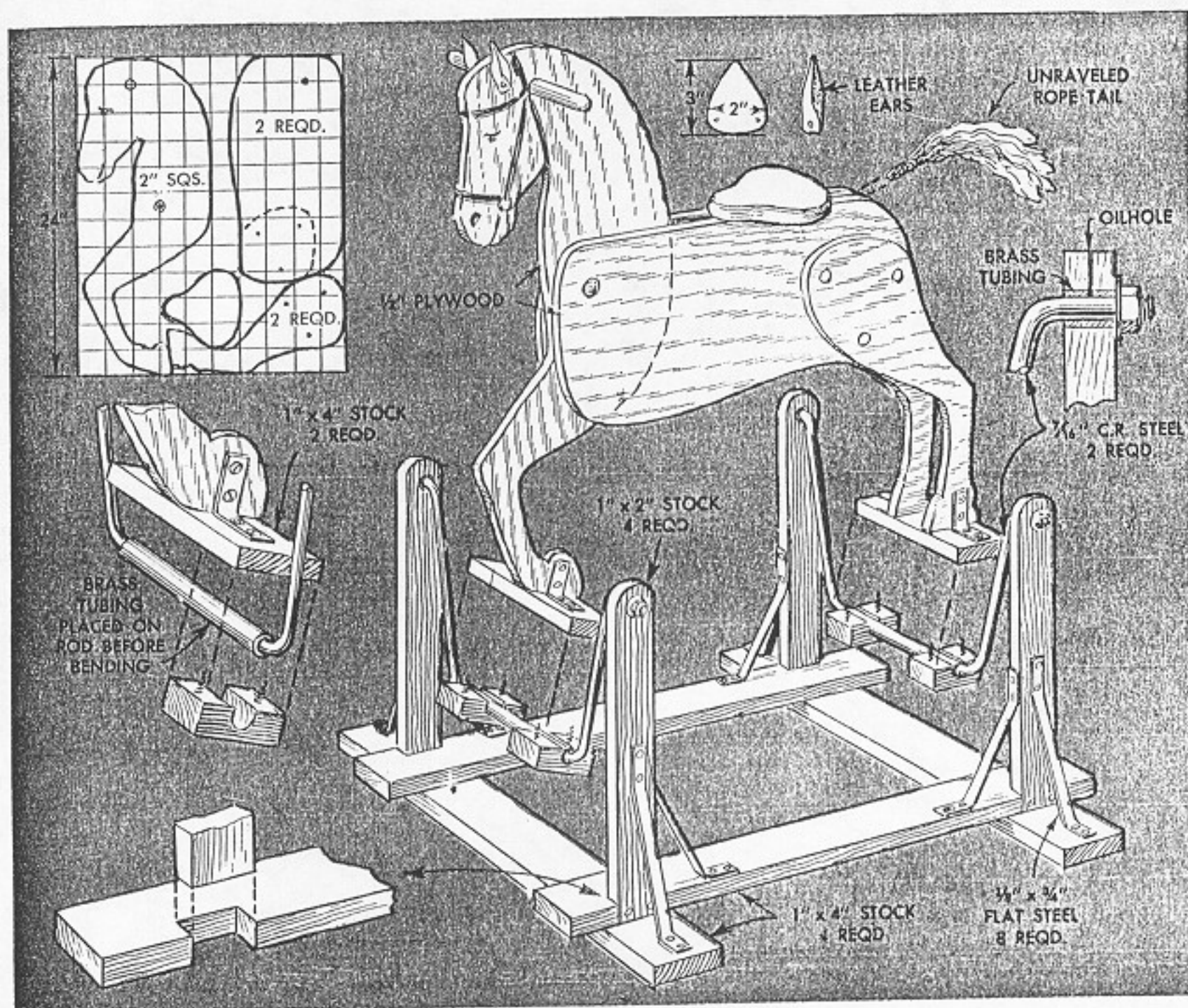


ROCKING HORSE

fitted in the horse's head. Short lengths of brass tubing inserted in holes drilled in the upper ends of the base uprights provide bearing surfaces for the rods. A small hole drilled vertically in the top of each upright, as shown in the detail on the right side of the drawing, provides a means of lubricating the bearing surfaces to reduce wear and noise.

To complete the rocking horse, the base is painted red, the rods green and the horse large irregular black spots on white, for a pinto. The tail is simply unraveled Manila rope bound at one end so that it can be glued in a hole drilled in the body spacer block as shown. The halter, mane and hoofs are painted on the horse in black. The ears are cut from the uppers of discarded leather shoes and glued and nailed on the head.

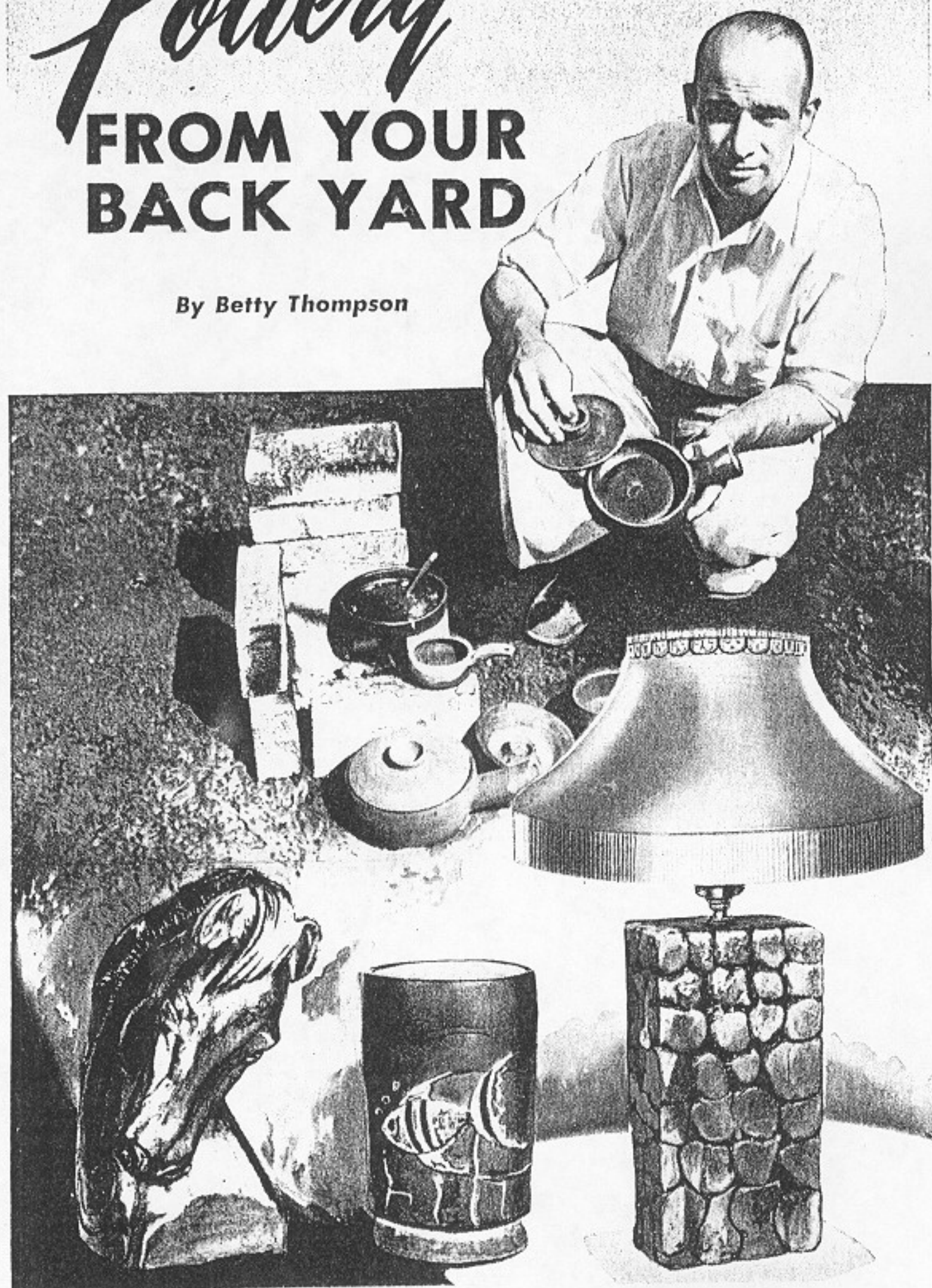
Hi Sibley, Nuevo, Calif.



Pottery

FROM YOUR BACK YARD

By Betty Thompson



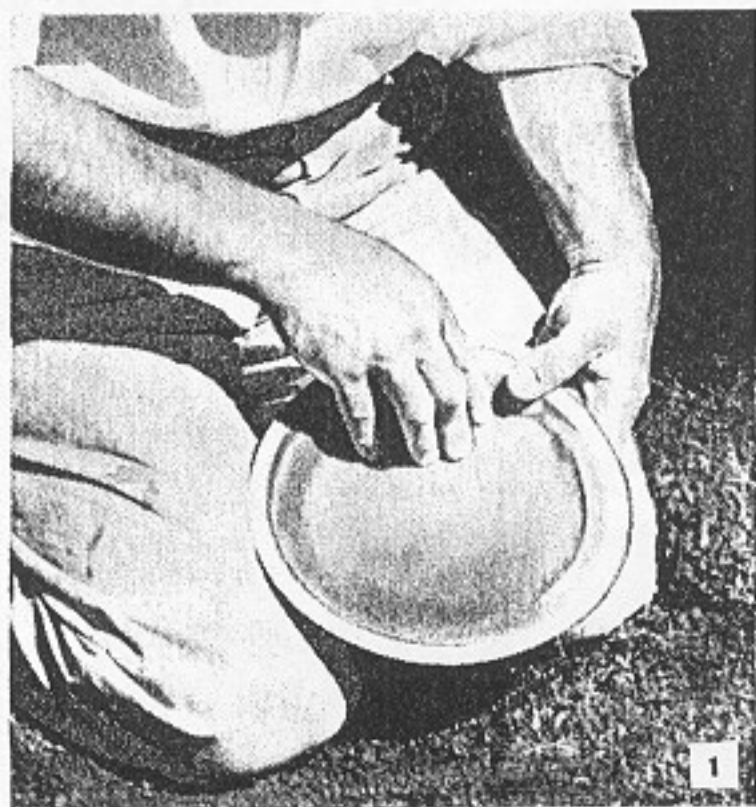
DID YOU KNOW that you can make fine clay pottery at practically no cost for materials or equipment? The clay usually can be had for the digging, right in your own back yard, and a quart or two of fresh milk will produce that soft, velvety glaze you've admired on fine pottery. There's no need to worry about intricate glazing processes or critical firing temperatures in ovens or kilns. The sun will take care of the drying process and firing is done in a charcoal fire built in an outdoor kiln made from a few loose bricks. Suitable clays are almost universally available. In its natural state, common clay will be found in a variety of colors ranging through shades of tan, green, blue and even black. However, as a rule, all ordinary clays turn a reddish brown when fired because of the presence of iron.

Art objects in clay, such as lamp bases, figurines, ash trays and vases are formed in various ways. Some can be thrown on a potter's wheel, while others, like the horse's head illustrated, must be modeled free-hand. The straight-sided vase, pictured on the opposite page, was made by simply pressing clay inside a cardboard carton. The base was added later. The rectangular lamp base was formed in a similar fashion, except that the clay was first worked into balls of a fairly uniform size and then pressed against the sides and ends of a cardboard shoe box.

Now, to carry out the simple process from the beginning, first locate the clay and test it by moistening a small amount with water, working until pliable. Then rub be-

tween the palms until it forms a long roll about $\frac{1}{2}$ in. in diameter. Coil the clay around the index finger. If the clay will roll easily around your finger without breaking, it is suitable for pottery making. Next, dig a pailful, or so, and place in a container, leveling off the top of the clay. Pour in an equal quantity of water, by measure, and allow to stand overnight. Then pour off the water slowly and skim off the soupy mass which has formed. Strain this through a fine-mesh screen to remove any foreign matter and allow to dry until it is once more cohesive. Now the clay is put through the kneading process known to potters as wedging. The purpose of this is to remove all the air bubbles and reduce the clay to a tight, compact mass that is neither so wet that it sticks to the fingers, nor so dry that it tends to crack while being kneaded or wedged. To get a good modeling clay of the proper working consistency, it is necessary to do a thorough job of wedging. After a period of wedging, slice the clay into thin strips with a fine wire held taut, then press the strips together again and repeat. In each wedging stroke, use the palms of both hands side by side, and apply sufficient pressure to flatten the mass of clay. After flattening in this manner, some potters pound the clay mass alternately with the palms. In reforming the clay mass after each stroke, care should be taken not to fold it so as to entrap air. After a thorough wedging, the clay is ready for immediate use.

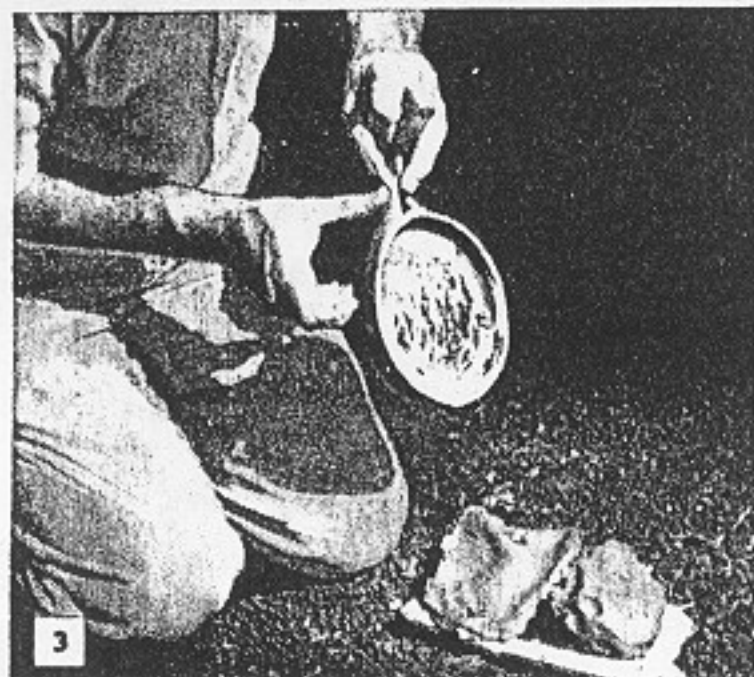
To further illustrate the process, a simple "one egg" skillet has been selected.



First step in making a pottery skillet is to mold the clay in a small pie tin as shown above

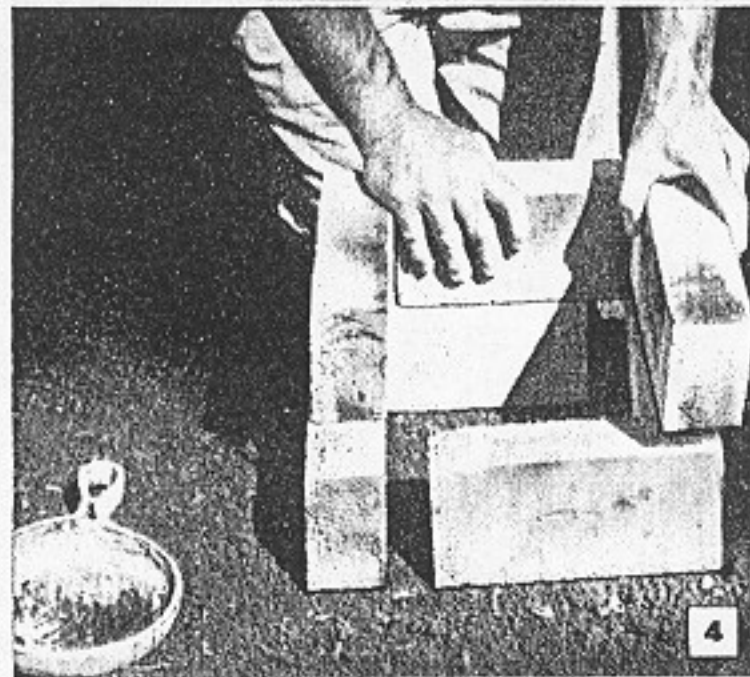


Roll the clay to a uniform thickness and then cut and bend a strip to form the skillet handle



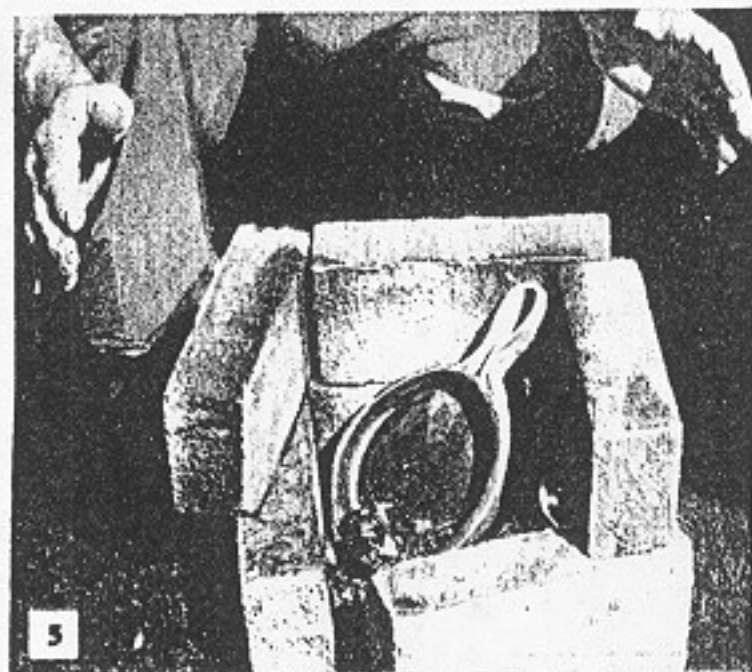
Skilled potters would either pat the clay mass into the shape required, or throw it on a wheel, but a simpler method is to mold the clay in a small pie tin into which a soft paper napkin has been pressed, Fig. 1. Build up the thickness in the tin to about $\frac{1}{2}$ in. and then smooth with the fingers and the back of a large spoon until the surface comes to the shape and degree of smoothness desired. Dry in the sun until the clay is sufficiently stiff to hold its shape. Then carefully tip it out onto a board, upside down. Smooth the bottom and flared edge with the back of a spoon. If the surface is too dry to smooth easily, just wet the spoon slightly to soften the surface of the clay.

Now, to make a handle, roll a small quantity of the clay to a uniform thickness. This can be done by placing the clay between two wooden strips of uniform thickness and rolling with a short length of 1-in. dowel, the ends of the dowel bearing on the

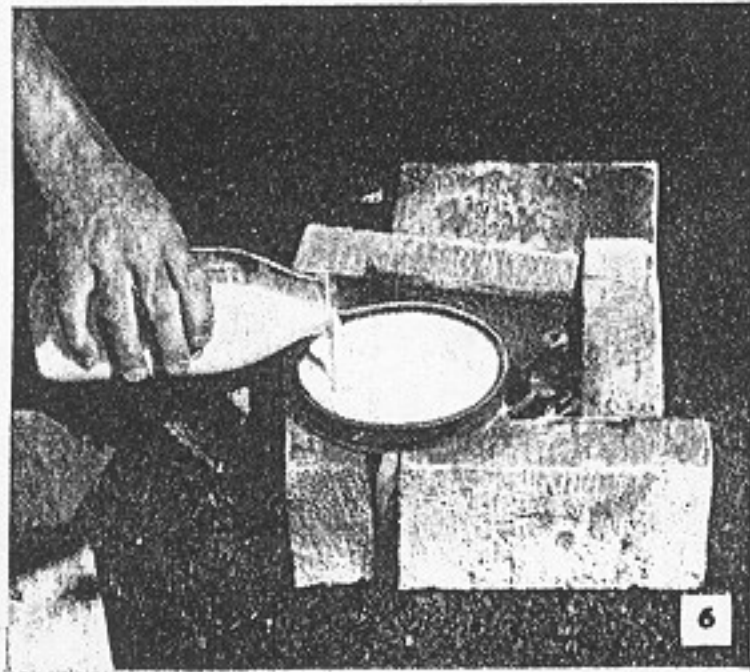


strips. Then cut a strip from the clay 2 in. wide and fold it to form the handle as in Fig. 2. Joining the handle to the body of any piece of pottery calls for special care. The body still should be moist on the surface but, as potters describe it, "leather hard." The handle should be of a somewhat softer consistency as it will dry more quickly. Place the handle on the body of the skillet in the required position, press it firmly in place and smooth the joint with the tips of the fingers until you form a uniform fillet at the joint, Fig. 3. Again set the work in the sun to dry.

Now, build a simple furnace, or kiln, for firing, using several bricks placed loosely on edge as in Fig. 4. Or, if you have one, an outdoor fireplace is just the thing. Use wood and charcoal for fuel. Before placing the work in the kiln, however, make sure that it is thoroughly dry, as otherwise it may crack during the warming-up pe-



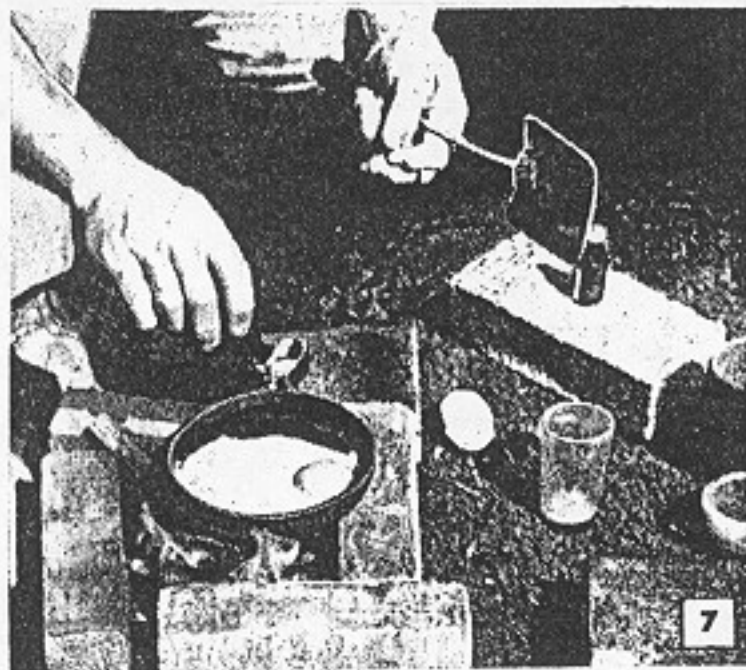
The work to be fired should be placed inside the improvised kiln, partly in the red-hot coals



Fill the skillet with fresh milk and simmer for eight hours to form a glaze on all the surfaces

riod. In any case, place the work in the improvised kiln before kindling the charcoal so that it will warm gradually to the maximum temperature. The time of firing averages about six hours, and it is necessary to keep the coals red hot during this period of time. The work should be directly in or on the bed of coals, Fig. 5, not above it. At the end of six hours of maximum heat, the work is removed and allowed to cool.

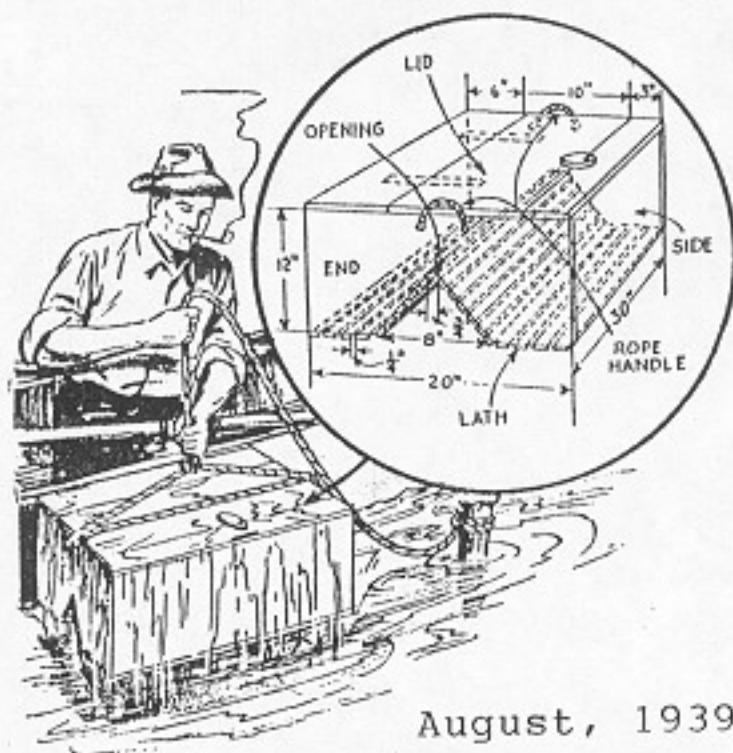
Now comes the glazing process and that's simplicity itself. Just fill the skillet brimful of fresh milk and let it simmer on the kitchen stove, or on the fireplace, for about eight hours. Then immerse the work in boiling milk for about 30 minutes, and there you are, ready for frying an egg as in Fig. 7. For art pottery, a novel color variation can be produced by using sweetened condensed milk instead of fresh milk. Coat the surface of the fired object with condensed milk and bake for an hour in an oven at 550-deg. temperature. This process results in an unusual bronze-black finish, very similar to the most costly art glazing. Not only art pieces can be finished in this latter type of glaze, but nearly all ornamental pieces are good subjects. The fresh-milk glaze does not color the clay, nor does it change the reflective properties of the surface appreciably.



If you purchase clay from dealers in art supplies be sure to get genuine clay, and not the product manufactured especially for low firing temperatures. Three to five pounds of clay should be ample for experiments. Keep the clay wrapped in a damp cloth until ready for use. If it hardens when unused over long periods, moisten with warm water and don't neglect to do a thorough job of wedging before using. This is the most important step to success in this process of pottery making.

POPULAR MECHANICS

Shrimp Trap Made from a Box Has Slat Bottom



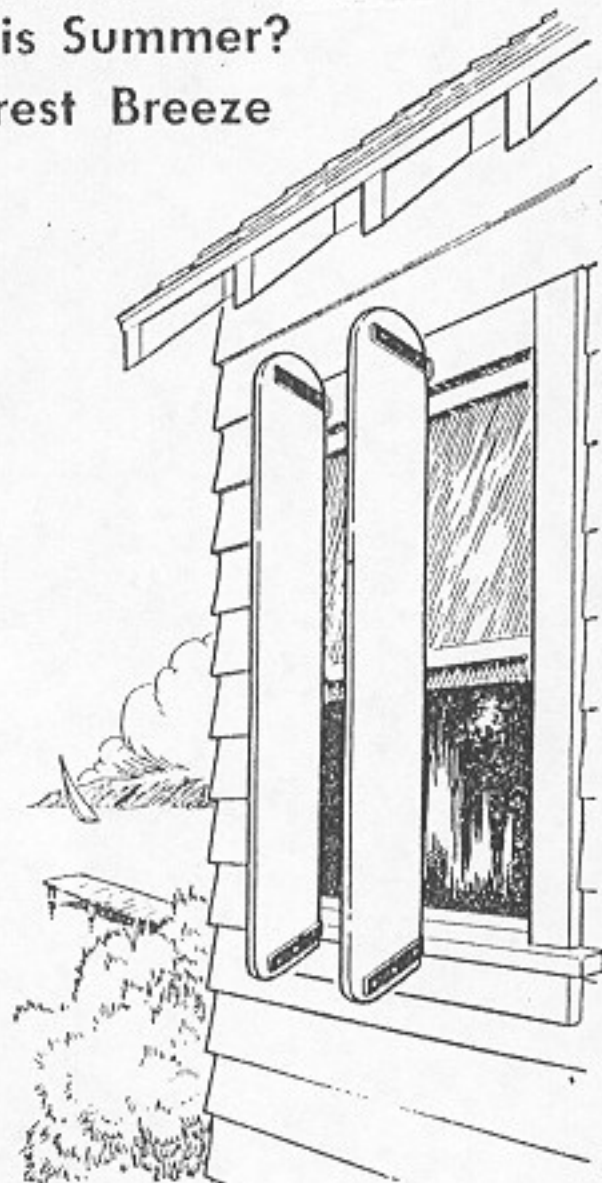
August, 1939

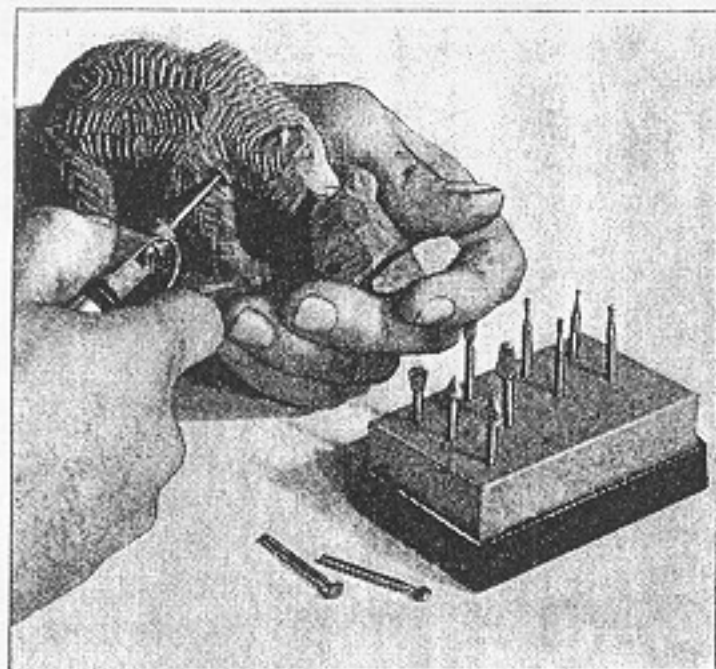
Fishing for shrimp, crawfish, eels, crabs and turtles is simplified with this trap, which is nothing more than a wood box with a slat bottom. Knock the bottom out of the box, cut two V notches in the ends as shown, and nail lath $\frac{1}{4}$ in. apart up to the point of the V, where an opening $\frac{3}{4}$ in. wide provides the entrance. Bait with meat or cottonseed cake. The mooring rope should be long enough to lift trap into skiff without untying the anchoring stage. —R. L. Schreiber, Chicago.

Popular Science JULY, 1945

No Electric Fan This Summer? Harness the Nearest Breeze

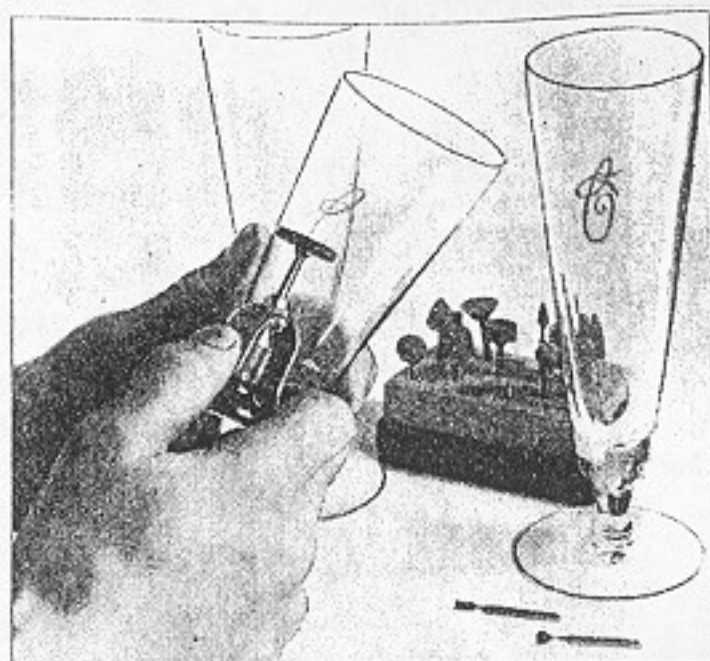
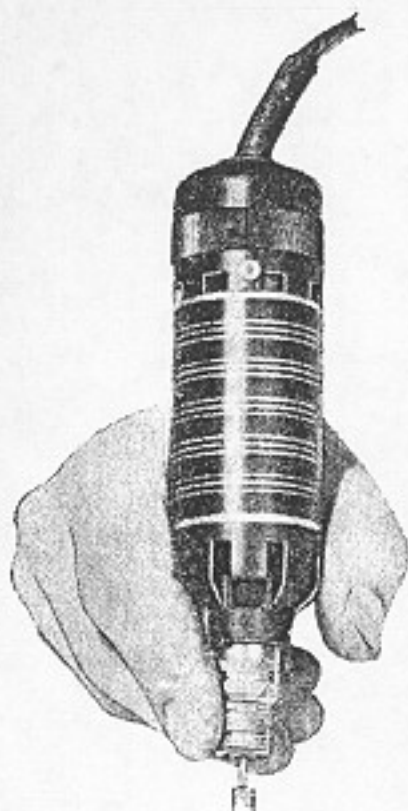
EVEN in the dim, forgotten days when electric fans could be had, they still had a price. But then, as now, the wind was free. This wind deflector takes advantage of the fact that every latitude has its major directional breeze which blows most of the time from one point of the compass. If your house is hot while your next-door neighbor's is relatively cool, the chances are that your windows run parallel to, instead of across, the direction of the wind. Deflectors or vanes, made of waterproof plywood or similar material and mounted on angle brackets as shown, will turn the fleeting breeze in upon you.—B. M.





Carving a small animal form out of solid wood. Note the variety of tools available.

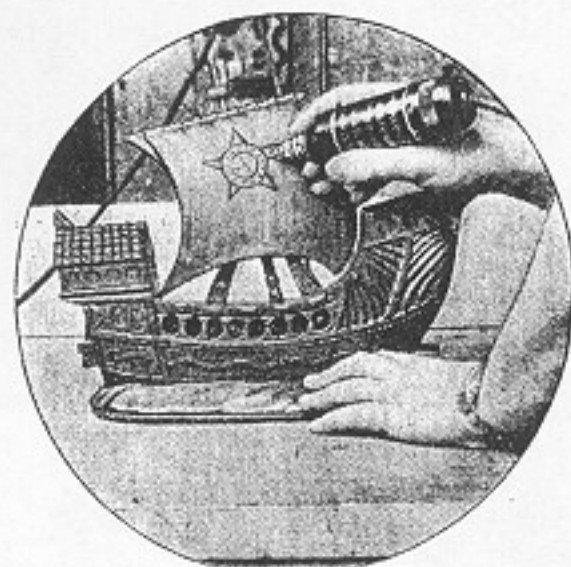
Popular Homecraft Nov. 1937



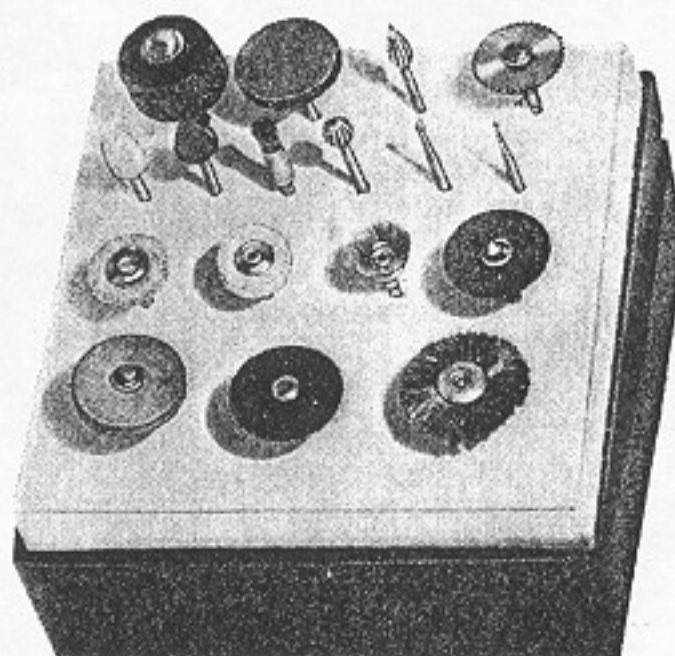
Etching on glass is a simple operation. Different designs may be placed inside the tumblers which are readily followed.

The Hand Grinder

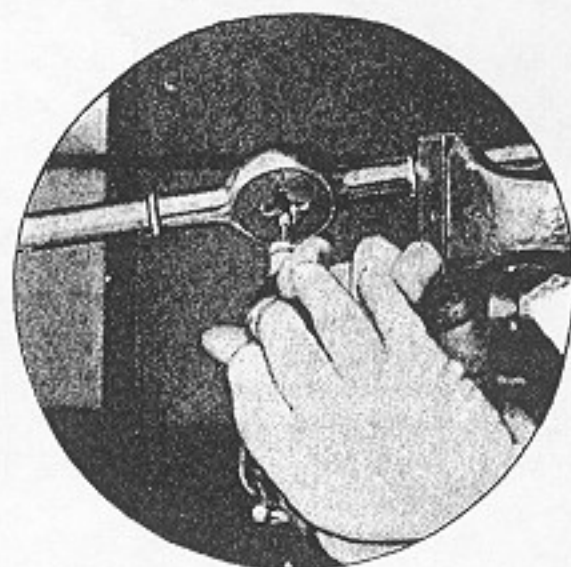
A Useful Tool



Carving an ornamental lamp, in the form of a boat, from solid stock. Note the clarity of form in the entire model.



Here are just a very few of the polishes, abrasives and tools procurable for use with the grinder.



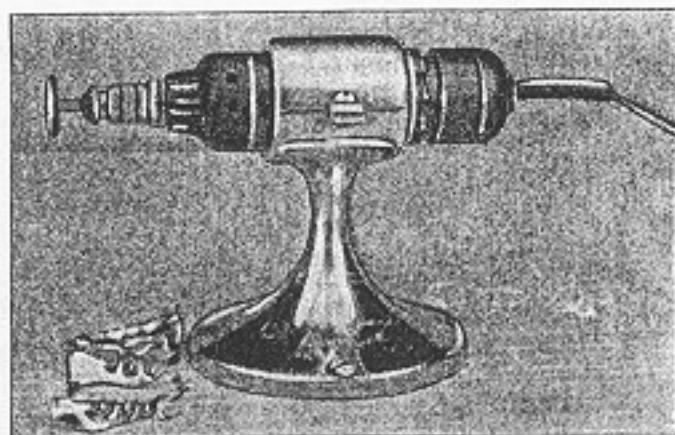
Sharpening a die while set in the stock. Free-hand grinding.

HOMECRAFTSMEN who have had no experience with a small hand grinder will find, upon investigation, that it may be put to an infinite variety of practical uses. To our mind, it is one of the tools which may be termed indispensable to any workman who wishes to minimize labor and produce fine results.

A grinder of this type, easily fitting the worker's hand, has a practically limitless number of attachments which are procurable for use with it.

It is possible to obtain drills, grinding wheels of many shapes and sizes, polishing wheels, sanding discs, sanding drums, wire wheels, felt wheels, rubber wheels, small saws and cut-off wheels. Also there is a large variety of cutters suitable for working in plastics, wood, soft metal and steel. Sanding discs and drums come in many sizes and in fine, medium and coarse grits.

The hand grinder may be made into a very efficient lathe with little labor. It may be used as a spindle carver on a simple post mount. It becomes a sensitive drill when properly mounted. And it may be used as a router by mount-



Grinder mounted on a bench stand. This converts the tool into a spindle carver, bench grinder and high-speed polisher.

ing it on a small frame with an adjustable collar to gauge the depth of cut.

By using selected stones or abrasives, the craftsman can etch on steel, glass and other materials. Many beautiful objects can be produced by etching, such as mirrors, picture frames and glassware. And suitable designs are obtainable for this kind of work.

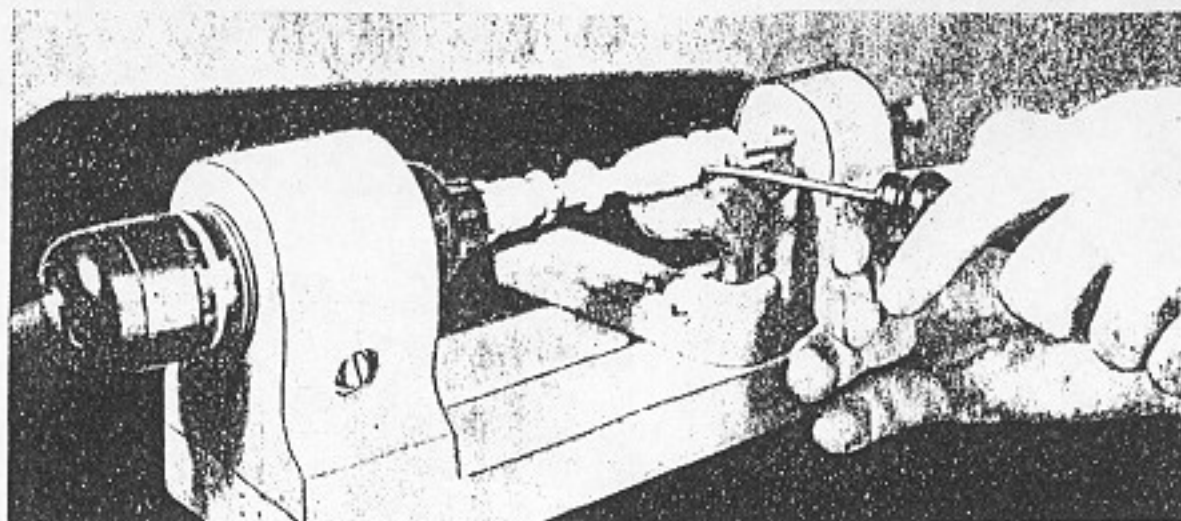
With the infinite variety of cutters obtainable, almost any kind of wood carving may be produced. Since the grinder operates at an exceedingly high speed, a fine, smooth cut results.

Linoleum block cutting for block printing may be done with this fine tool. Many designs which involve laborious hand work become simple when worked out with the hand grinder. Polishing small objects is also simplified when a tool of this type is utilized.

Every craftsman feels the need of odd tools in his workshop which are ordinarily not listed in catalogs. Such may be made with the aid of the hand grinder, including punches for leather stamping, chasing chisels, small wood chisels, background stamps for wood carving, and many others.

Jobs of soldering may be done with greater ease by using the grinder to clean and finish the work after the solder has been applied. Burrs may be removed quickly from castings with comparative ease and especially in practically inaccessible places, by using small tools with the grinder. It is especially fine for drilling, sanding and finishing in the production of models. It is actually an all-around tool which may be put to a great variety of uses in producing better work with a minimum of labor. Many such operations are illustrated. Probably no tool which the workman may possess can be put to such a variety of practical uses as the hand grinder.

+



Improved Lathe Turns Small Objects

By L. M. Mitchell

A MODELMAKER'S lathe may be easily constructed at home for small diameter work. Consisting of nothing more than a simplified wooden lathe built to hold a small electric hand grinder, this versatile tool is ideal for work requiring high speeds and for jobs not adapted to the larger conventional types of workshop lathes. The one sketched has great flexibility. The motor, for instance, may be saddled in the block and it may be used as an off hand grinder. The tailstock is so constructed that a small table may be attached or the lathe can be used as the foundation for a tiny milling table. In short, this little lathe is almost a tiny workshop.

It may be constructed wholly from small bits of lumber to be found in the workshop plus a few bolts and wood screws. The bed which runs the full length is made of two pieces of $\frac{3}{4}$ " x $1\frac{1}{2}$ " stock, placed so as to leave $\frac{1}{4}$ " clearance between the two pieces. This opening is allowed for tool post and tailstock adjustment.

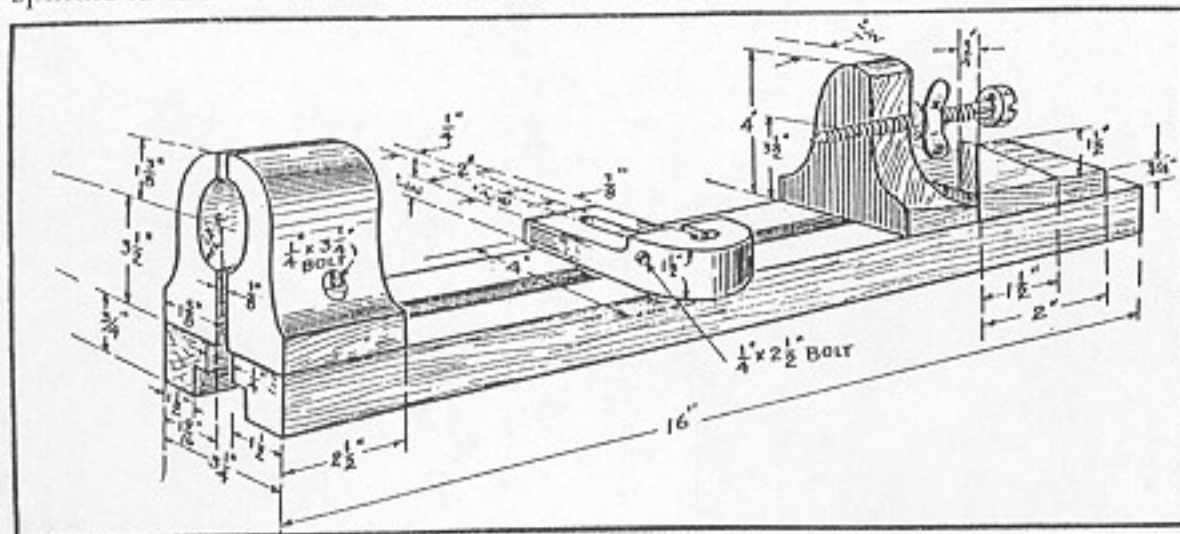
The tailstock spindle must not be installed before the entire lathe is completed. The spindle must then be centered with great care. A misstep at this point will result in all work having a slightly tapered effect. The correct method of centering this spindle is to assemble the lathe, mount

the motor, and bring tailstock to motor chuck. An impression of the chuck upon the tailstock will give the proper horizontal location for the spindle. At this location bore a hole slightly smaller than the procured lag screw which serves as a tailstock center. Thread the lag screw into this hole.

Large steel knitting needles will make the necessary wood turning tools. Four such tools constitute a fairly complete set: one with a fish-tail end, one with an inverted fish-tail end, one straight across and one slanting at a 45-degree angle. These knitting needles are inserted into old handles of discarded ice-picks left over from the days before the electric refrigerator.

On this lathe may be turned out chessmen which will be original in design and delight the heart of the recipient who plays chess. A set of checkers was made on the lathe shown in the photograph, and the wood for the set came from a cherry tree chopped down in the owner's backyard. The fisherman can cut out his own lures and lacquer them red, yellow or white to suit his fancy.

One outstanding advantage of this ingenious lathe is its portability. It may be unbolted from the workbench and moved to any other location within reach of an electric socket.



'Painting' With DYED FEATHERS

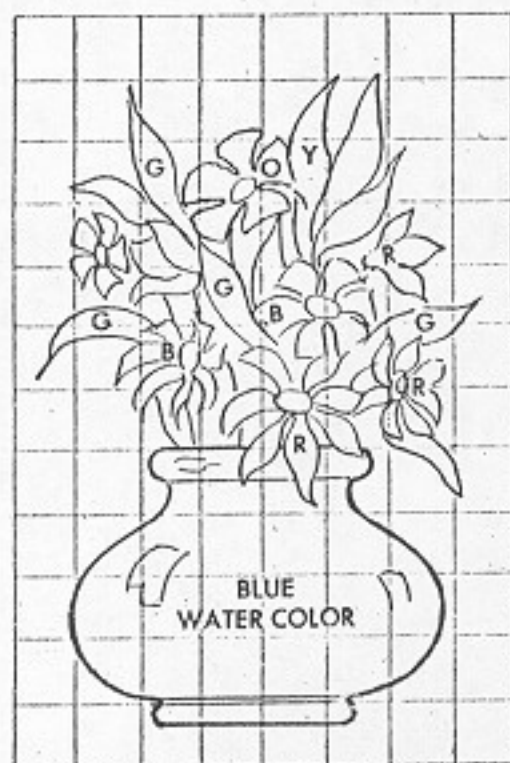
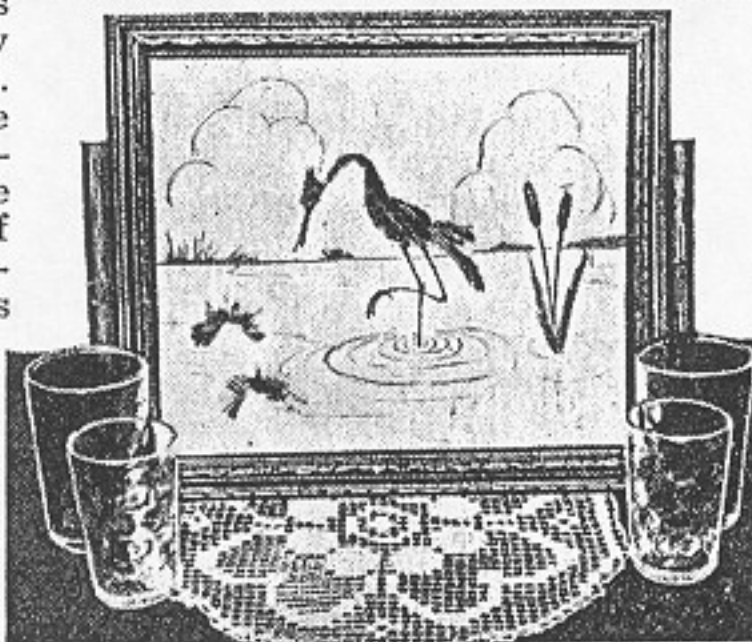
POPULAR MECHANICS JANUARY 1948

By Elma Waltner

"PAINTING" pictures with feathers is merely the trick of arranging dyed feathers over the traced outline of some familiar object, such as a bird or bouquet of flowers. Start with white feathers, preferably chicken feathers plucked from the breast or back. Do not use wing or tail feathers with heavy, stiff spines. Wash feathers in mild soapsuds and warm water to remove the natural oil. Rinse thoroughly.

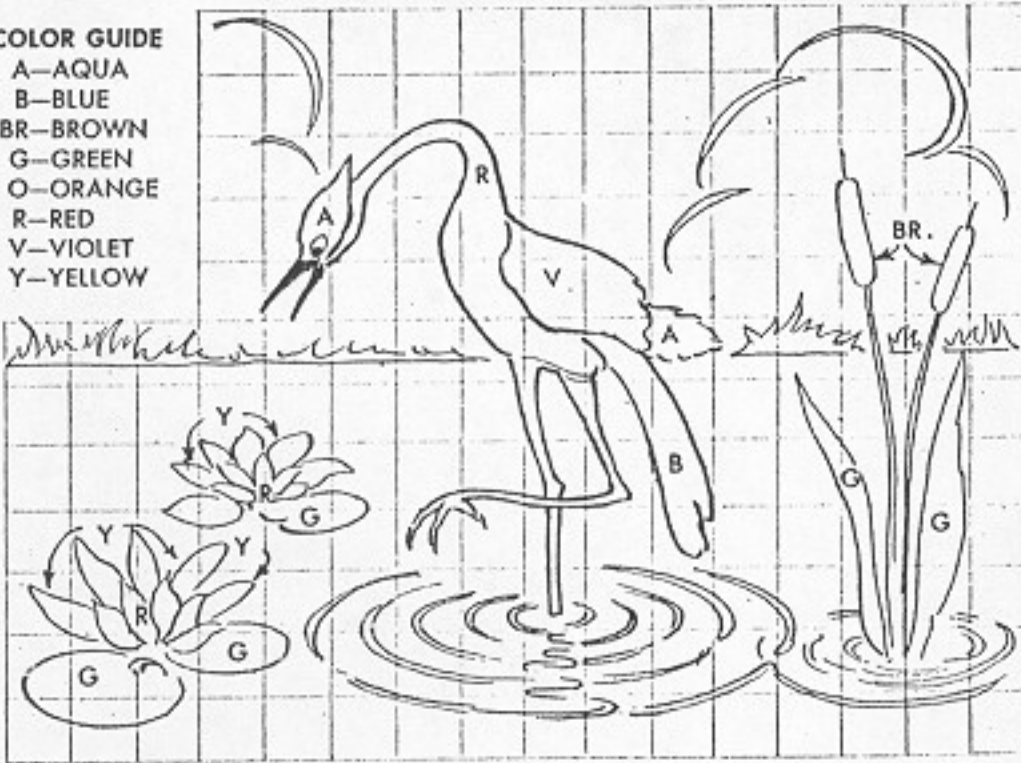
Ordinary fabric dyes are used. Follow the dye manufacturer's directions as to quantities and methods of preparation. Feathers usually dye best if dipped when wet. Right after rinsing is the time to dip so have the dye ready then. Dip the whole feather so that the color "takes" uniformly. Place on newspapers to dry, taking care that the feathers are not curled when laid on the paper.

Details below give crosshatched outlines and key the colors of the feathers used in making the bouquet and bird pictures shown in the photos at the right. Notice in the details that the flower petals and leaves are made by gluing the colored feathers over the outlines. However, the vase is painted directly on the paper using either blue water colors or artists' oil colors. Likewise, in the bird picture the lilies, pads, and the body, head and tail of the bird, and the heads and leaves of the cattails are made by gluing the colored feathers over the outlines. Balance of the details are filled in with water colors. Pictures are framed under glass in ordinary picture frames which can be hung on the wall or made into attractive serving trays by gluing handles to the frames as indicated in the lower photo. Short lengths of dowel in various sizes make attractive handles.



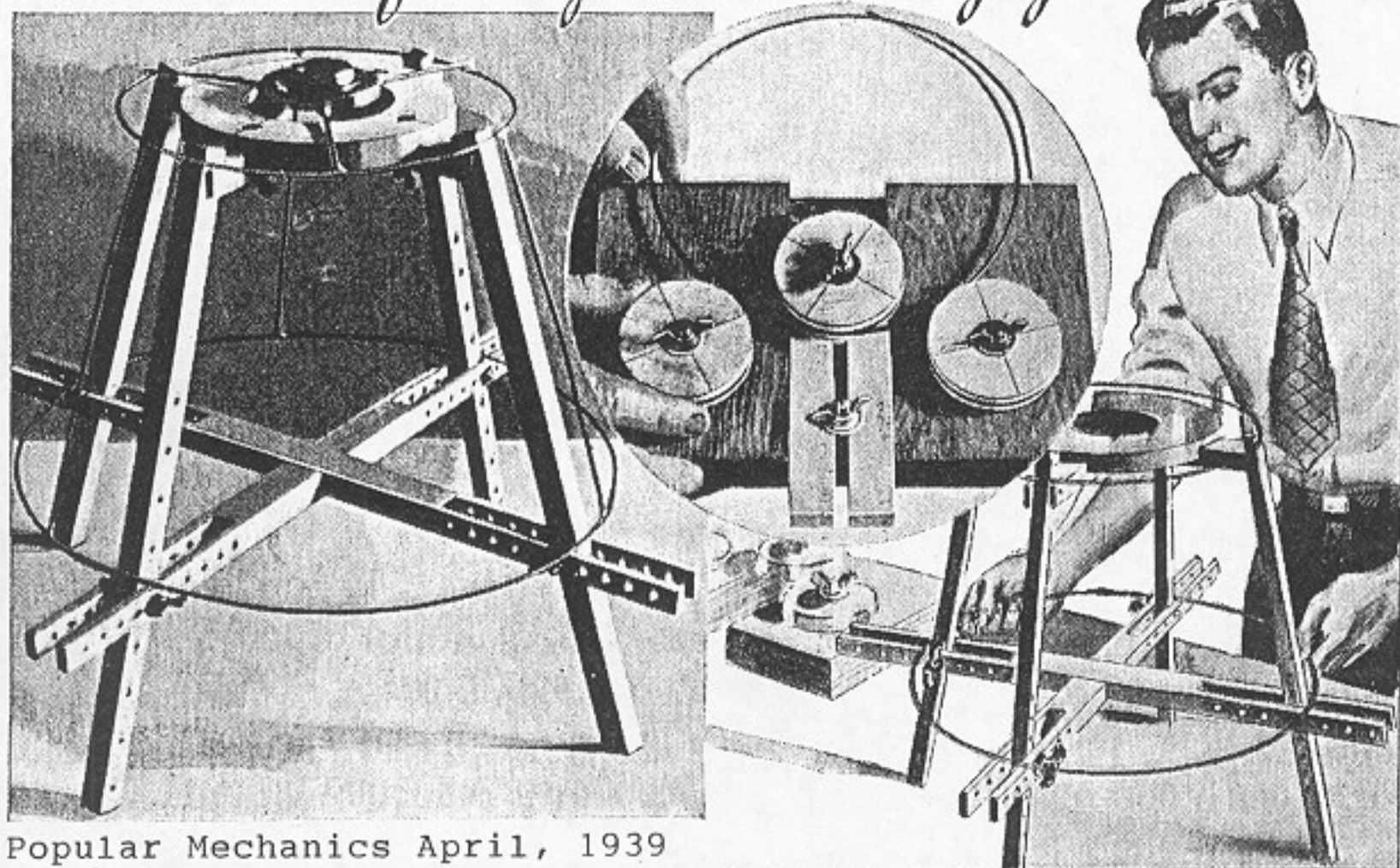
COLOR GUIDE

A—AQUA
B—BLUE
BR—BROWN
G—GREEN
O—ORANGE
R—RED
V—VIOLET
Y—YELLOW



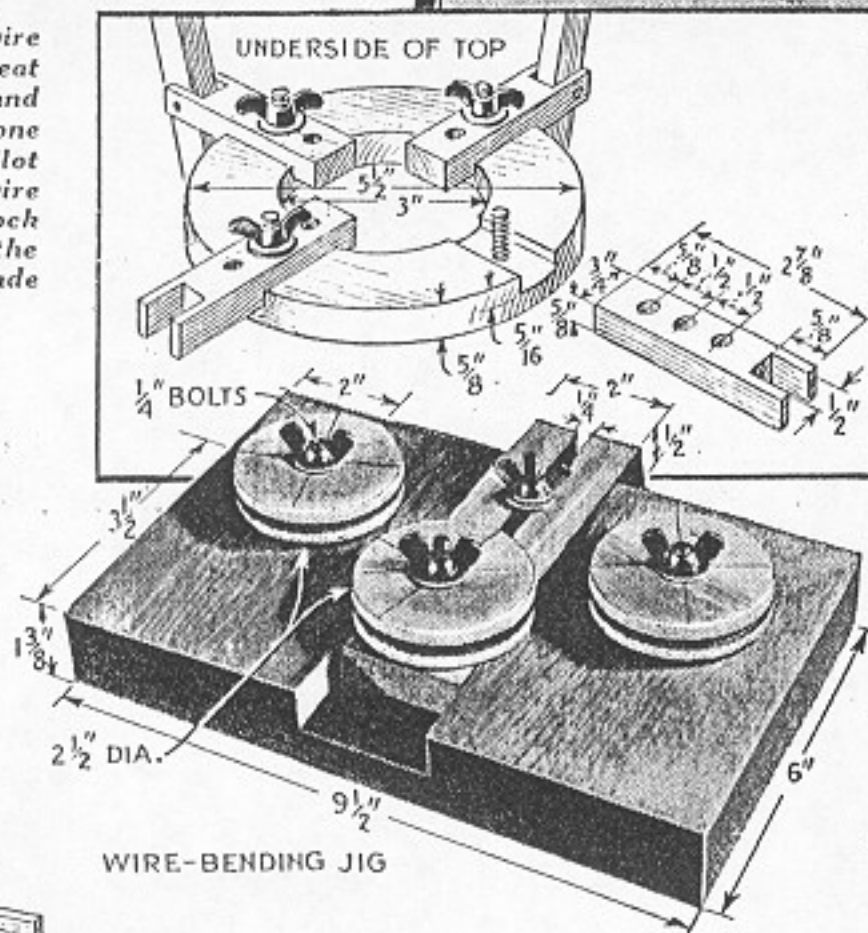
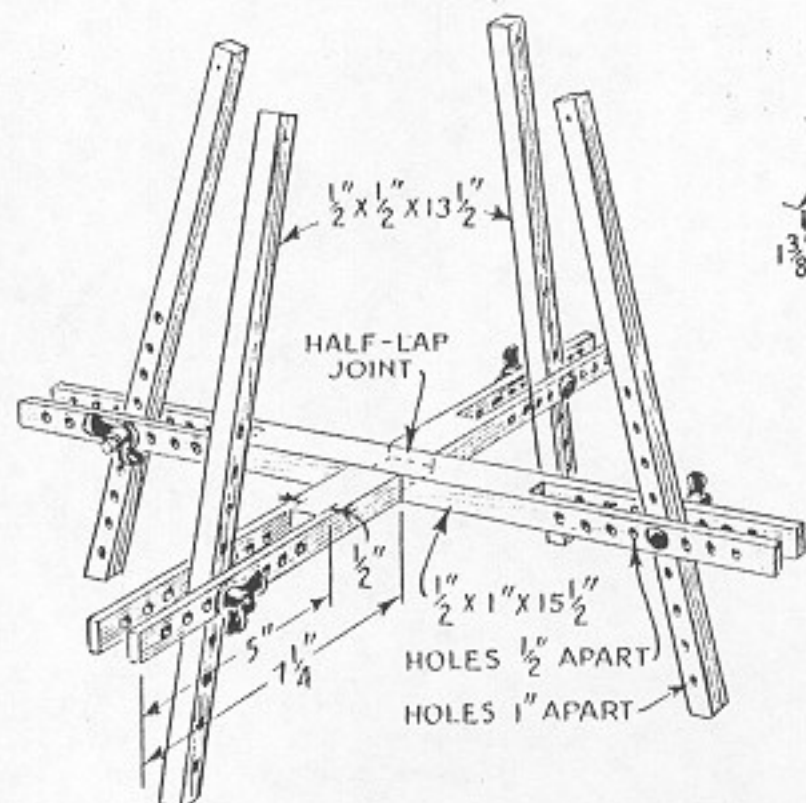
WIRE LAMPSHADE FRAMES

assembled quickly with these jigs



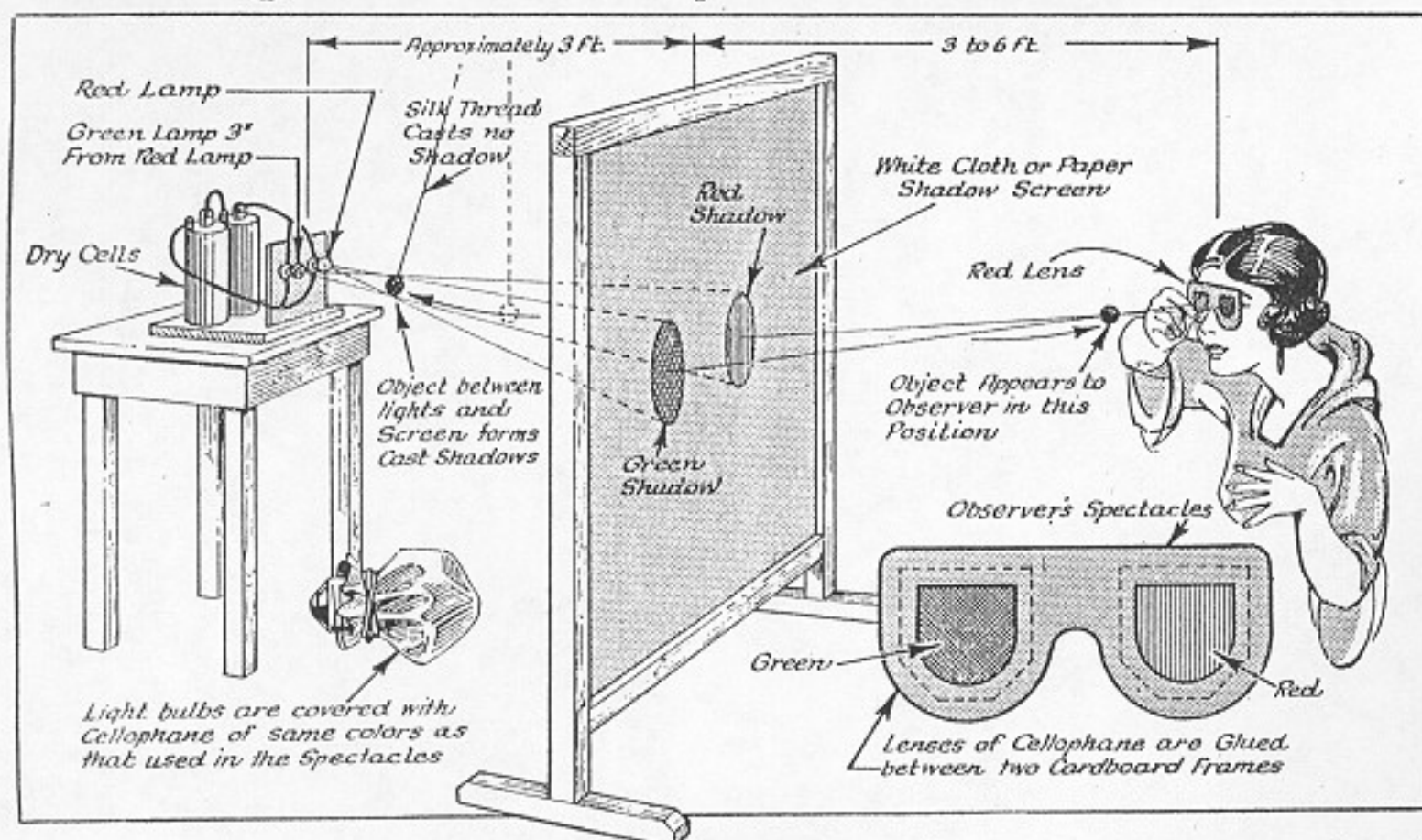
Popular Mechanics April, 1939

These jigs are adjustable for any regular size of wire lampshade frame and make it easy to turn out a neat job in a fraction of the time required by other hand methods. To make time in assembling frames one should adopt a definite procedure, making up a pilot model first to get the exact size of the various wire parts, which are then cut to length. Run the stock for the rings through the bending jig, solder the meeting ends, and you're ready to finish each shade in turn on the assembly jig



Use hardwood for all parts of each jig and take special care to space the holes accurately in the vertical and horizontal members of the assembly jig. To make the top ring of the latter, cut right-angle grooves in a piece of stock 6 in. square, then saw to the inside and outside diameters given in the detail above

Making Stereoscopic Shadow Pictures



With the use of common colored cellophane the home experimenter can make an interesting experiment in stereoscopy. The shadow of the ball will appear to be solid and round when viewed with the light filtering frame.

MANY people have seen motion pictures or shadows at the theater which appear to have depth, but they do not realize that the same illusion may be produced at home in a very simple but effective experiment.

This is especially easy to perform as an experiment since the introduction of colored cellophane. Motion pictures with depth require a special film, but the shadow pictures as shown here are not at all complicated.

Apparatus Needed

The only things you'll need to investigate the effects of the stereoscopic phenomenon are two small flashlight bulbs and sockets, a battery, and some sheets of colored (red and green) cellophane.

Cover two flashlight bulbs, one with red and the other with green cellophane. Make a pair of spectacles of the same materials. See the drawing above. You can get the colored cellophane from most grocery stores, at a stationery store, or off the wrappings from candy bars. See that the red has a slight orange tint, as a better result is obtained.

Arrange the lights and the screen as shown on the drawing. The room should be dark except for the red and the green lights. View the shadow at a distance of about 3 to 6 feet on the opposite side of the screen from the lights.

Stereoscopic Effect

Hold the glasses as shown on the drawing,

that is, with the red on the same side as the red light. As an object is moved from the screen toward the lights, the shadow on the screen appears to be moving from the screen right out at your eyes. One of the most effective ways to demonstrate the illusion of stereoscopic depth is to swing a small object on the end of a string back and forth toward the lights.

The explanation of the phenomenon is as follows: We judge the distance of objects from us by their size and by the amount of convergence (turning in) of the eyes that is required to see them clearly. Both principles are found in this experiment.

Effect Obtained Anaglyphically

As an object is moved toward the lights the size of the shadow on the screen becomes larger. It appears to be coming toward the observer.

The use of the two colors merely filters out corresponding colors, and causes the eye to see each its proper image. This color filtration and control of the eye is, in stereoscopic phenomena, termed "anaglyphic" and the two color objects, "anaglyph." Phonetically, the word is pronounced annaglyff.

A number of stunts can be tried. Hold a large knife near the screen and slowly move it toward the lights. Toss a small ball with one hand from near the screen to the other hand held under the lights. Each one of the audience will think it is being thrown in his face.

Popular Mechanics November 1955



Purdue expert erected this plastic greenhouse on his farm. Structure half this size can be built for \$75

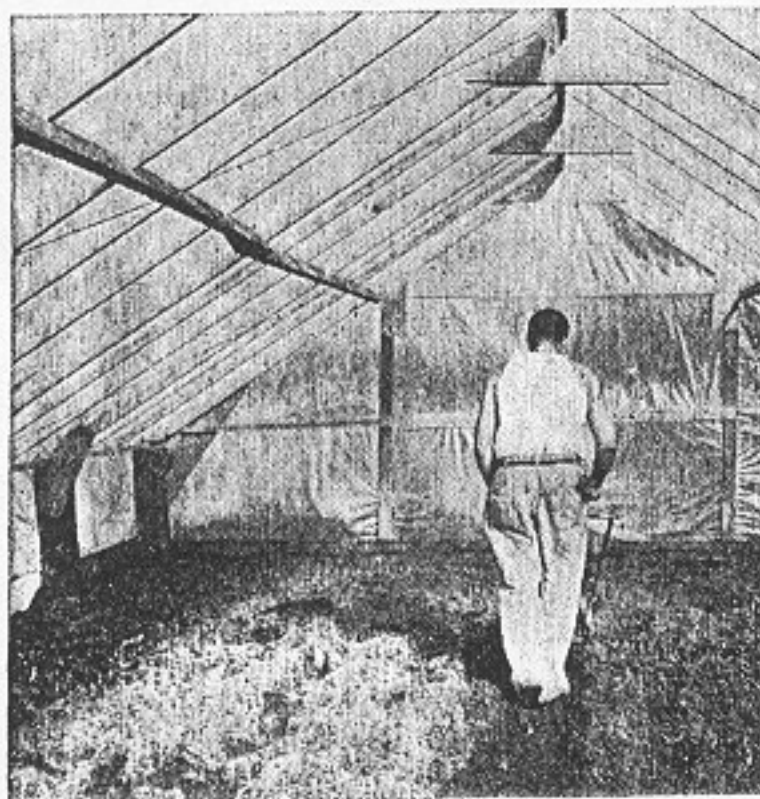
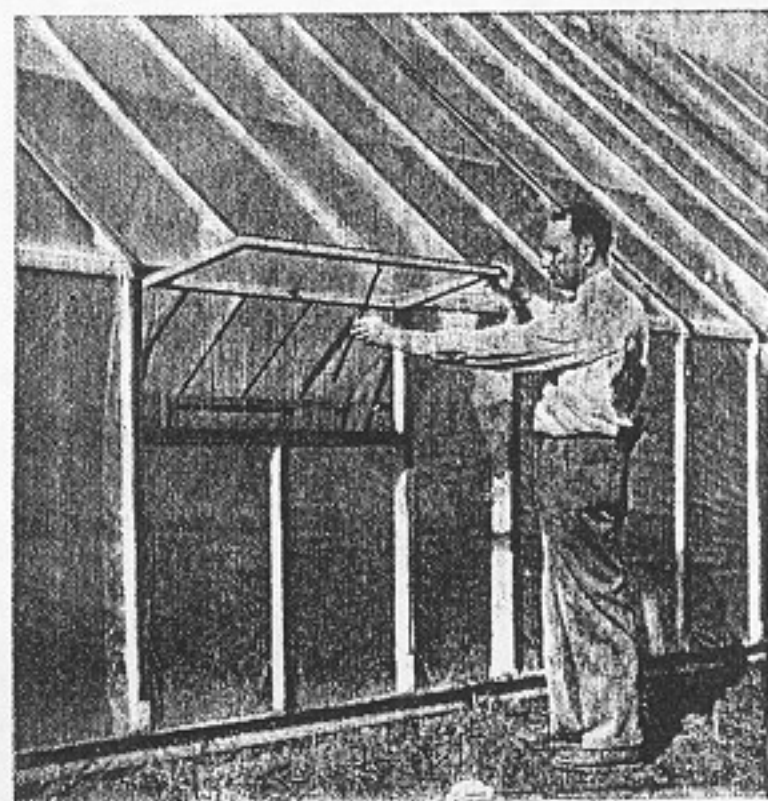
Plastic Replaces Glass in Low-Cost Greenhouse

YOU CAN GROW your own vegetables and even flowers this winter in a plastic-covered greenhouse that covers 400 square feet and costs only \$75 to build. Heating will add to the cost, but you may decide it's worth the expense to have blooms and fresh vegetables in midwinter. Designed at Purdue University, the back-yard greenhouse consists of a plastic cover stretched over a wooden framework of two-by-twos and two-by-fours. The framework is rigid, yet there are no shadow-casting cross braces. It is of truss design, with glued-and-

nailed gusset plates at all joints in the trusses. The cover, which is replaced every year for about \$10, withstands heavy winds, hail, rain and snow. It is easily patched. The plastic retains moisture exceedingly well, which makes for less watering. Because the covering is slightly opaque, heat from the sun does not build up in the plastic greenhouse as much as it does in the conventional hothouse. Swingout windows made of plastic-covered wooden frames are opened for short periods every day or so to ventilate the building.

Plastic-covered swing-out windows provide ventilation for experimental greenhouse at Purdue University

Two-by-fours and two-by-twos make up simple framework of greenhouse. Braces at joints give strength



The following "Three Bears" is the original of what you know as "Goldilocks And The Three Bears" This was taken from Harper's Monthly, Jan., 1875



THE STORY OF THE THREE BEARS.

For Little Folks.

FROM ROBERT SOUTHEY'S "THE DOCTOR."

"A tale which may content the minds
Of learned men and grave philosophers."
GASOBYNE.

ONCE upon a time there were Three Bears, who lived together in a house of their own in a wood. One of them was a Little, Small, Wee Bear, and one was a Middle-sized Bear, and the other was a Great, Huge Bear. They had each a pot for their porridge; a little pot for the Little, Small, Wee Bear, and a middle-sized pot for the Middle Bear, and a great pot for the Great, Huge Bear. And they had each a chair to sit in; a little chair for the Little, Small, Wee Bear, and a middle-sized chair for the Middle Bear, and a great chair for the Great, Huge Bear. And they had each a bed to sleep in; a little bed for the Little, Small, Wee Bear, and a middle-sized bed for the Middle Bear, and a great bed for the Great, Huge Bear.

One day, after they had made the porridge for their breakfast, and poured it into their porridge-pots, they walked out into the wood while the porridge was cooling, that they might not burn their mouths by beginning too soon to eat it. And while they were walking, a little old Woman came to the house. She could not have been a good, honest old Woman; for first she looked in at the window, and then she peeped in at

the key-hole; and seeing nobody in the house, she lifted the latch. The door was not fastened, because the Bears were good Bears, who did nobody any harm, and never suspected that any body would harm them. So the little old Woman opened the door and went in; and well pleased she was when she saw the porridge on the table. If she had been a good little old Woman, she would have waited till the Bears came home, and then, perhaps, they would have asked her to breakfast; for they were good Bears—a little rough or so, as the manner of Bears is, but for all that very good-natured and hospitable. But she was an impudent, bad old Woman, and set about helping herself.

So first she tasted the porridge of the Great, Huge Bear, and that was too hot for her; and she said a bad word about that. And then she tasted the porridge of the Middle Bear, and that was too cold for her; and she said a bad word about that too. And then she went to the porridge of the Little, Small, Wee Bear, and tasted that; and that was neither too hot nor too cold, but just right; and she liked it so well that she ate it all up: but the naughty old Woman said a bad word about the little porridge-pot, because it did not hold enough for her.

Then the little old Woman sat down in the chair of the Great, Huge Bear, and that was too hard for her. And then she sat down in the chair of the Middle Bear, and that was too soft for her. And then she sat down in the chair of the Little, Small, Wee Bear, and that was neither too hard nor too soft, but just right. So she seated herself in it, and there she sat till the bottom of the chair



came out, and down came hers, plump upon the ground. And the naughty old Woman said a wicked word about that too.

Then the little old Woman went up stairs into the bed-chamber in which the Three Bears slept. And first she lay down upon the bed of the Great, Huge Bear; but that was too high at the head for her. And next she lay down upon the bed of the Middle Bear; and that was too high at the foot for her. And then she lay down upon the bed of the Little, Small, Wee Bear; and that was neither too high at the head nor at the foot, but just right. So she covered herself up comfortably, and lay there till she fell fast asleep.

By this time the Three Bears thought their porridge would be cool enough; so they came home to breakfast. Now the little old Woman

as had left the spoon of the Great, Huge Bear standing in his porridge.



"Somebody has been at my porridge!"

said the Great, Huge Bear, in his great, rough, gruff voice. And when the Middle Bear looked at his he saw that the spoon was standing in it too. They were wooden spoons; if they had been silver ones, the naughty old Woman would have put them in her pocket.

"Somebody has been at my porridge!"

said the Middle Bear, in his middle voice.

Then the Little, Small, Wee Bear looked at his, and there was the spoon in the porridge-pot, but the porridge was all gone.

"Somebody has been at my porridge, and has eaten it all up!"

said the Little, Small, Wee Bear, in his little, small, wee voice.

Upon this the Three Bears, seeing that some one had entered their house, and eaten up the Little, Small, Wee Bear's breakfast, began to look about them. Now the little old Woman had not put the hard cushion straight when she rose from the chair of the Great, Huge Bear.

"Somebody has been sitting in my chair!"

said the Great, Huge Bear, in his great, rough, gruff voice.

And the little old Woman had squatted down the soft cushion of the Middle Bear.

"Somebody has been sitting in my chair!"

said the Middle Bear, in his middle voice.

And you know what the little old Woman had done to the third chair.

"Somebody has been sitting in my chair, and has sat the bottom of it out!"

said the Little, Small, Wee Bear, in his little, small, wee voice.

Then the Three Bears thought it necessary that they should make farther search; so they went up stairs into their bed-chamber. Now the little old Woman had pulled the pillow of the Great, Huge Bear out of its place.

"Somebody has been lying in my bed!"

said the Great, Huge Bear, in his great, rough, gruff voice.

And the little old Woman had pulled the bolster of the Middle Bear out of its place.

"Somebody has been lying in my bed!"

said the Middle Bear, in his middle voice.

And when the Little, Small, Wee Bear came to look at his bed, there was the bolster in its place; and the pillow in its place upon the bolster; and upon the pillow was the little old Woman's ugly, dirty head—

which was not in its place, for she had no business there.

"Somebody has been lying in my bed—and here she is!"



said the Little, Small, Wee Bear, in his little, small, wee voice.

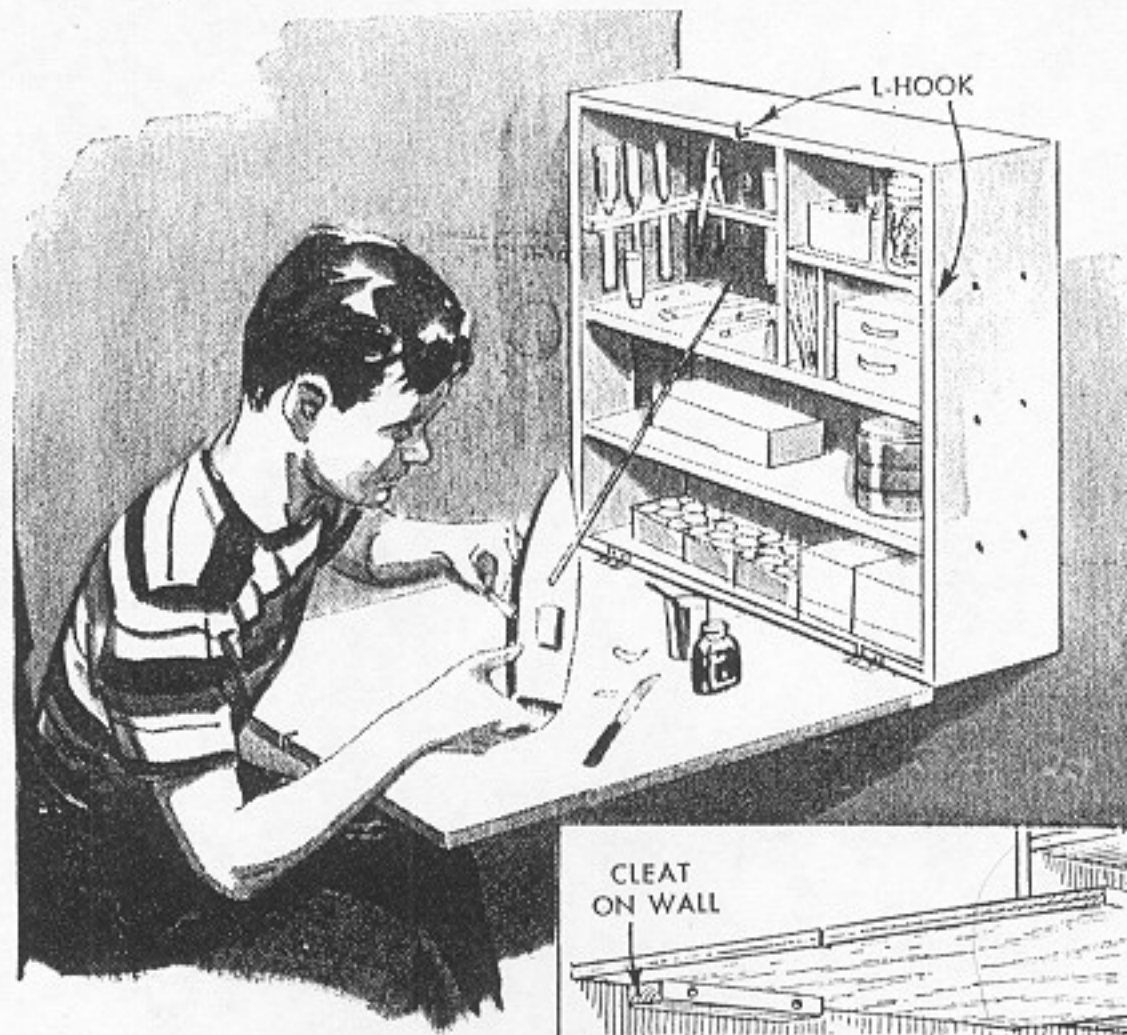
The little old Woman had heard in her sleep the great, rough, gruff voice of the Great Huge Bear; but she was so fast asleep that it was no more to her than the roaring of wind or the rumbling of thunder. And she had heard the middle voice of the Middle Bear, but it was only as if she had heard some one speaking in a dream. But when she heard the little, small, wee voice of the Little, Small, Wee Bear, it was so sharp and

so shrill that it awakened her at once. Up she started; and when she saw the Three Bears on one side of the bed, she tumbled herself out at the other, and ran to the window. Now the window was open, because the Bears, like good, tidy Bears, as they were, always opened their bed-chamber window when they got up in the morning. Out the little old Woman jumped; and whether she broke her neck in the fall, or ran into the wood and was lost there, or found her way out of the wood and was taken up by the constable and sent to the House of Correction for a vagrant as she was, I can not tell. But the Three Bears never saw any thing more of her.

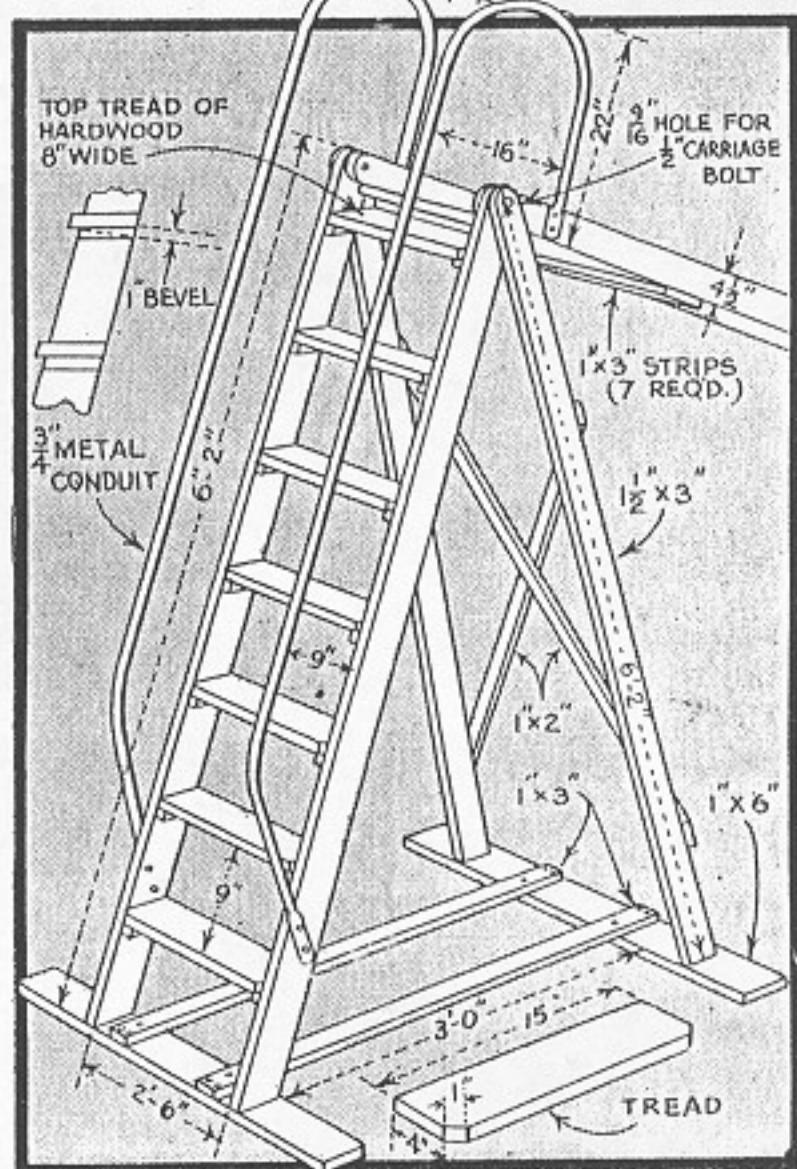
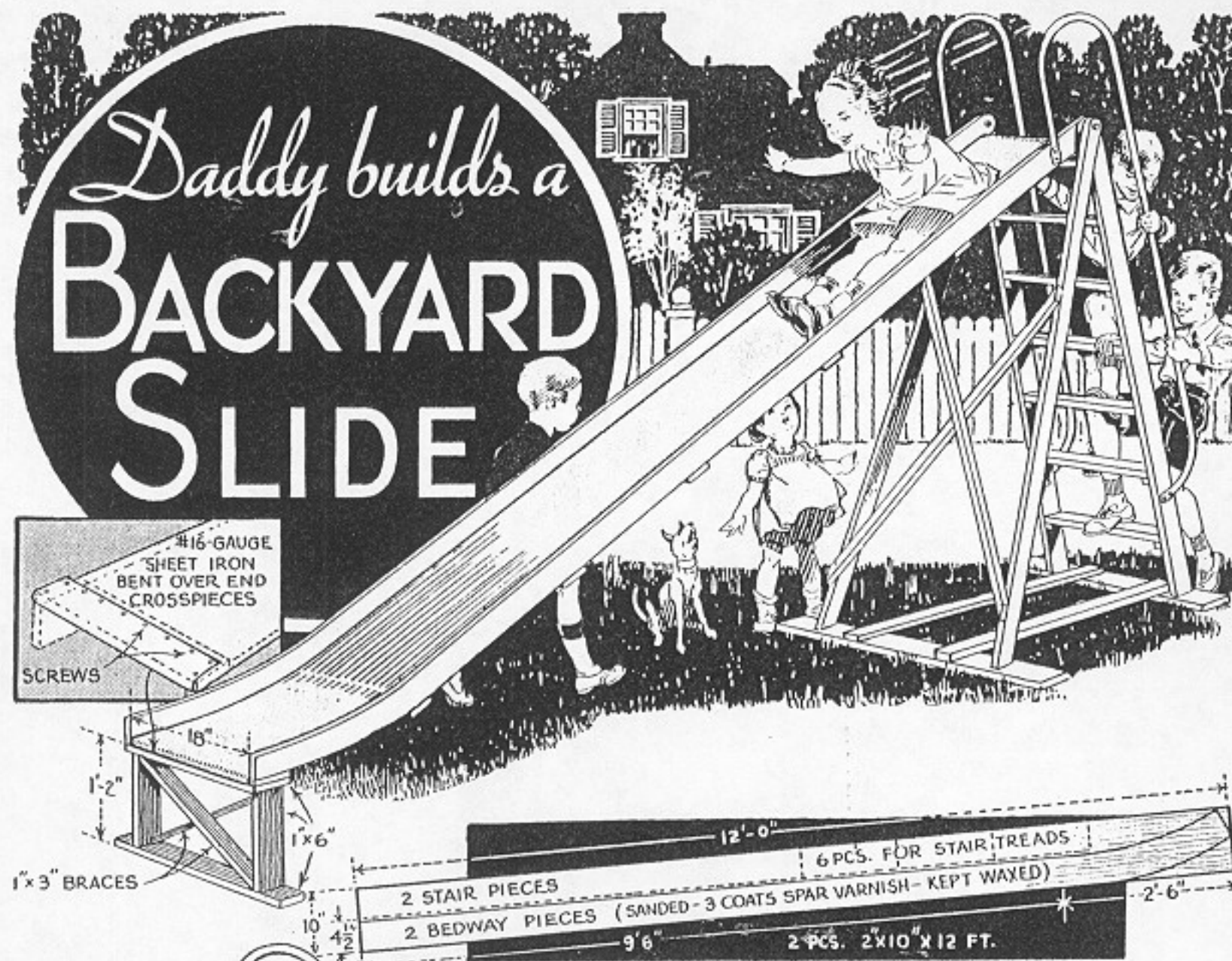


Popular Mechanics February 1958

Hobby Cabinet Provides Both Storage and Work Surface

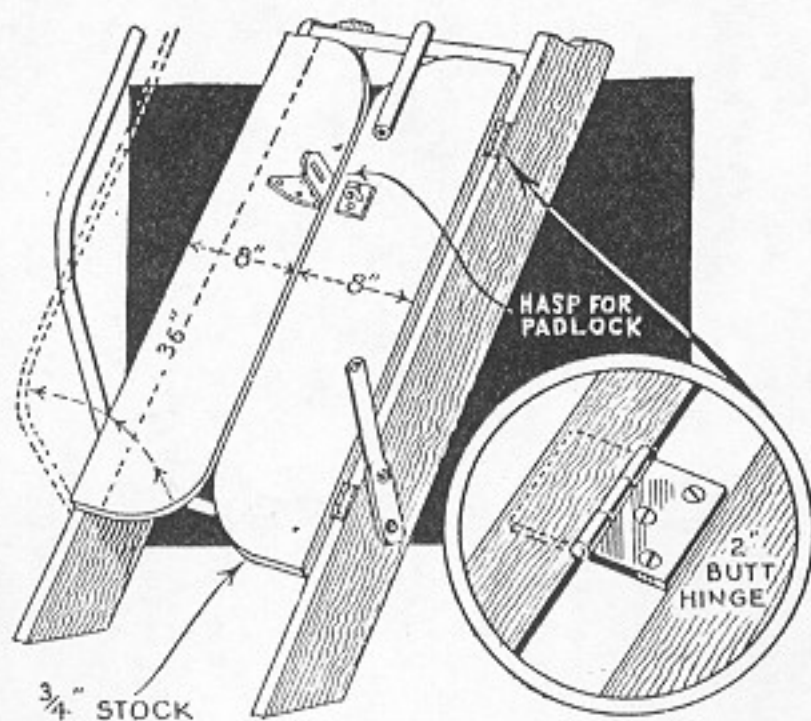


Fastened to the wall in a corner of a room, this small wall cabinet serves both as a storage place for hobby supplies and as a workbench. Depending on the hobby concerned, the cabinet can have two or three shelves, and whatever vertical partitions prove necessary. The door, which can be $\frac{3}{8}$ or $\frac{1}{2}$ -in. plywood, is hinged to the bottom shelf. When the door is dropped to a horizontal position to be used as a workbench, it rests on a cleat attached to the adjacent wall. If the cabinet is located on a wall not adjacent to another, chains or brackets can be used to support it. For a latch, a L-hook is used at side or top, fitting a notch in the door.



Popular Mechanics July, 1939

Set up in your backyard, this slide will afford your children and their friends many hours of pleasure safe from street traffic, and it can be dismantled and stored for the winter in a jiffy. A wide slide bedway, stairs and "take-off plate" all make for safety of the children, and a couple of hinged boards near the bottom of the stairs can be locked over them to keep tiny tots from climbing the slide without supervision. A sheet-iron bedway assures long life, and hardwood bedway pieces well sanded and varnished reduce the splinter hazard to a minimum.



DRIVE YOUR WELL

Popular Mechanics 1939

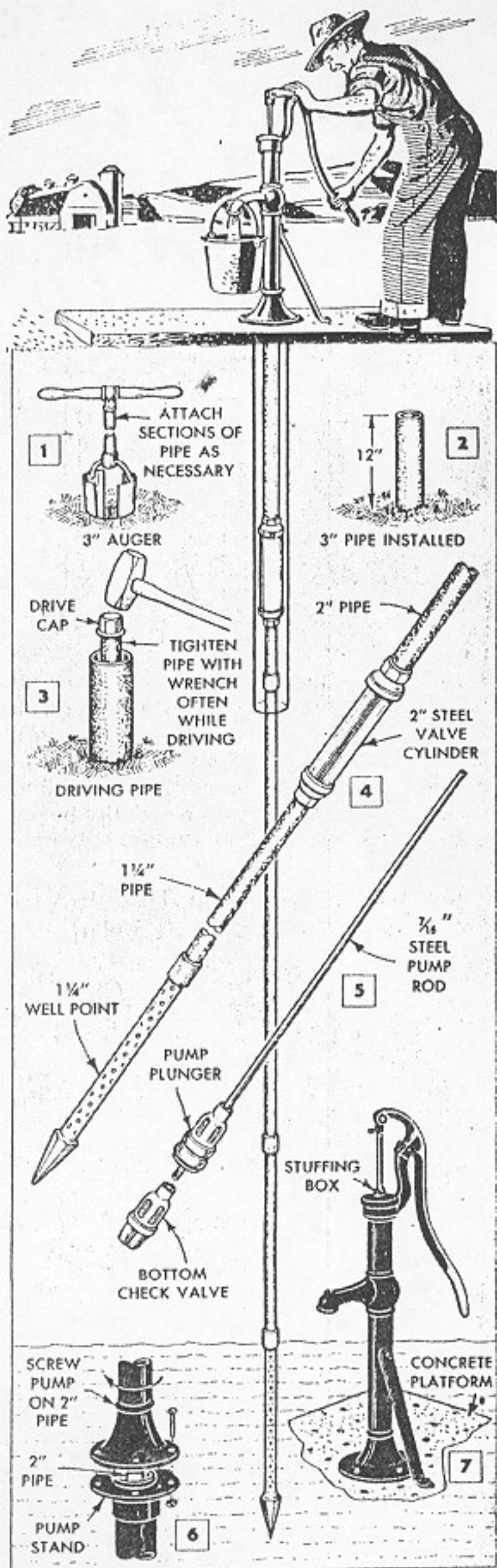
Where water-bearing strata are quite near the surface it's easy to put down a well

By Raymond J. Karpen

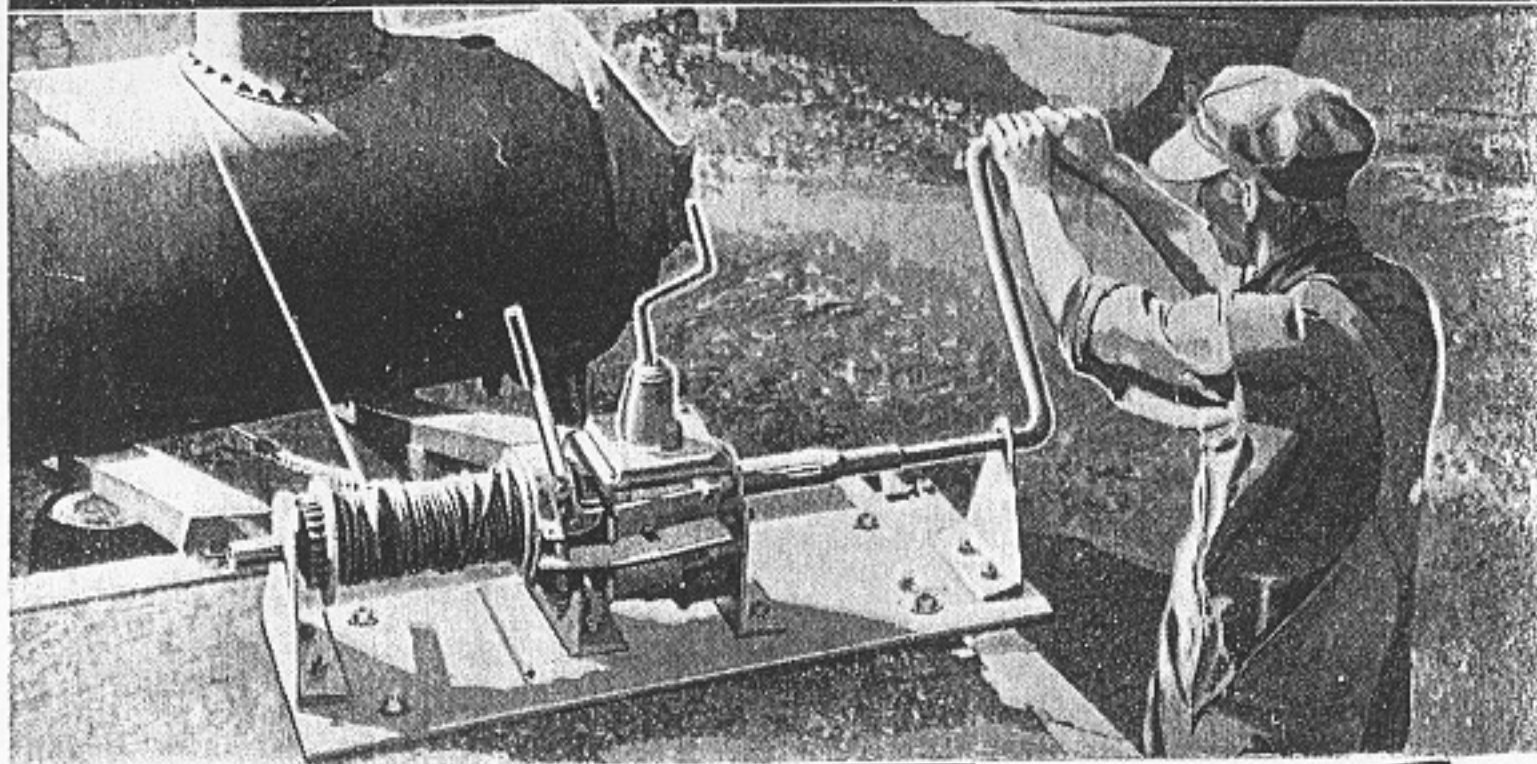
IN MANY LOCALITIES where the ground is fairly level over comparatively large areas you can generally tap a good water supply by merely driving down a pipe fitted with a well point. If you plan to drive a well you may save time by making inquiry about the depth of wells in the vicinity. Experienced well drillers often can tell with remarkable accuracy, just by the look of things, where you will be most apt to strike water with a well point and at approximately what depth. Once you have good advice on these points the rest is quite easy to accomplish.

Begin as in Fig. 1 with a 3-in. posthole auger of the type having a handle of pipe. Have at hand several 3-ft. lengths of pipe threaded to fit the handle, together with couplings. Run the auger down as far as it will go easily, then unscrew the handle, turn on another section of pipe and proceed, lengthening the auger handle in the same way until you reach a depth of 8 to 12 ft. Here the auger with its long handle becomes unwieldy and, besides, in most localities, a depth of 8 ft. will put the pump cylinder below the maximum frost depth. Now drive a length of 3-in. pipe into the auger hole to serve as a casing, Fig. 2. Next, assemble the well point and one or more lengths of pipe of sufficient combined length to reach above ground when the well point touches the earth at the lower end of the casing. Draw these joints tight. Screw on the drive cap, Fig. 3, and you're ready to go. Take it easy with the sledge, as heavy blows may buckle the pipe or have the effect of deflecting the point. As a rule the pipe drives quite easily. From there on it's merely a matter of adding pipe in short lengths until the driven point reaches water. Usually you can tell quite accurately when the point enters water-bearing strata. Check with a weighted cord lowered inside the pipe. If the point strikes a rock on the way down, it's usually best to pull it and start over again. Any attempt to force the point past a stone by heavy sledging may cause buckling.

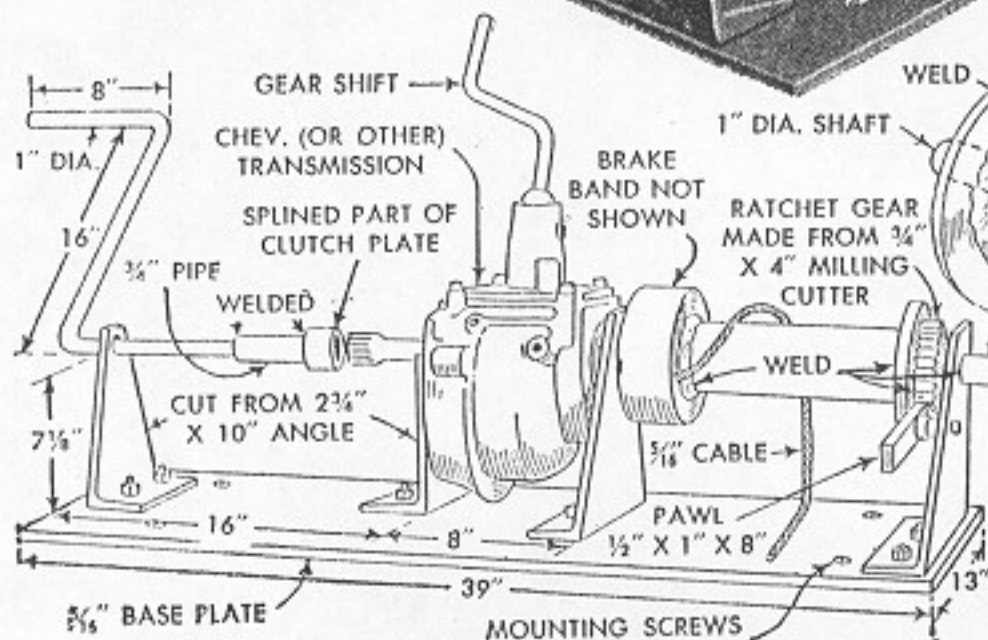
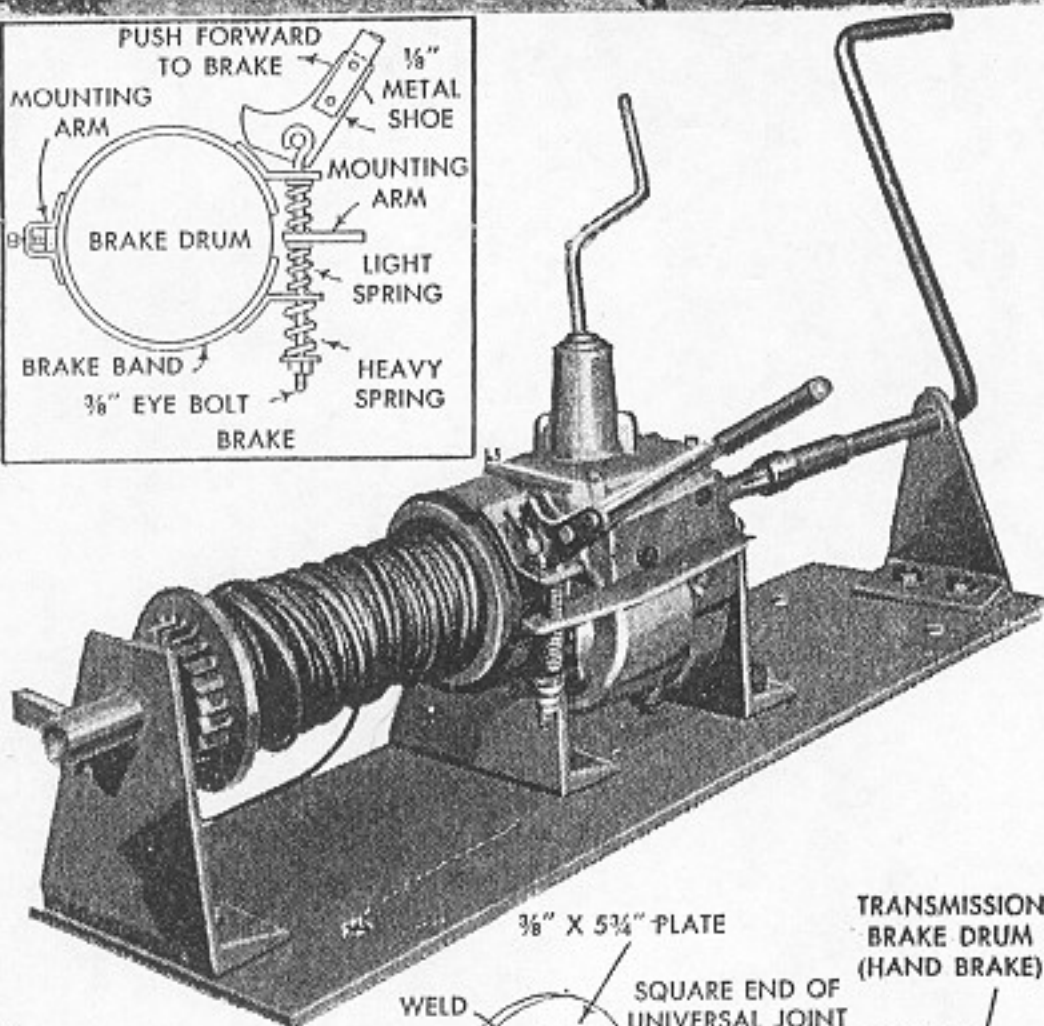
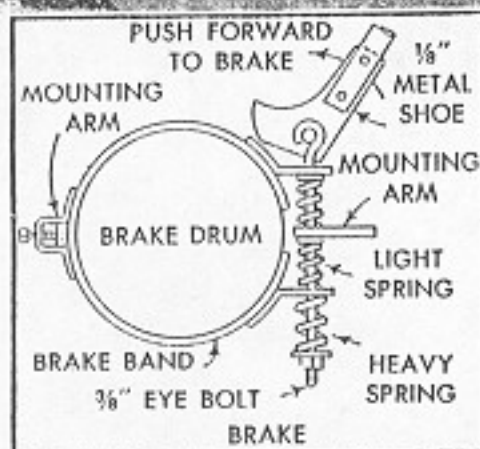
When you're sure of water, assemble the pump cylinder, Figs. 4 and 5, and drive this down until the top end of the pipe reaches to a point an inch or so above the casing. Then install the pump as in Fig. 6 and pour a concrete platform as in Fig. 7. Slope the platform so water runs off on all sides.



Powerful DRUM HOIST Made from Scrap



With this homemade hoist, you can lift loads weighing more than a ton. For each pound of pressure exerted on the handle, there is an upward pull of 30 lbs. on the load. Construction is largely torch cutting and welding. The base plate has holes for mounting, preferably on the bed of a truck, permitting full sweep of the handle. However, the hoist can be used on the ground if the handle is disengaged after each half swing. Although the brake mechanism is not essential, it is useful for dropping a load. An old auto transmission gives a free neutral position as well as a selection of gear ratios

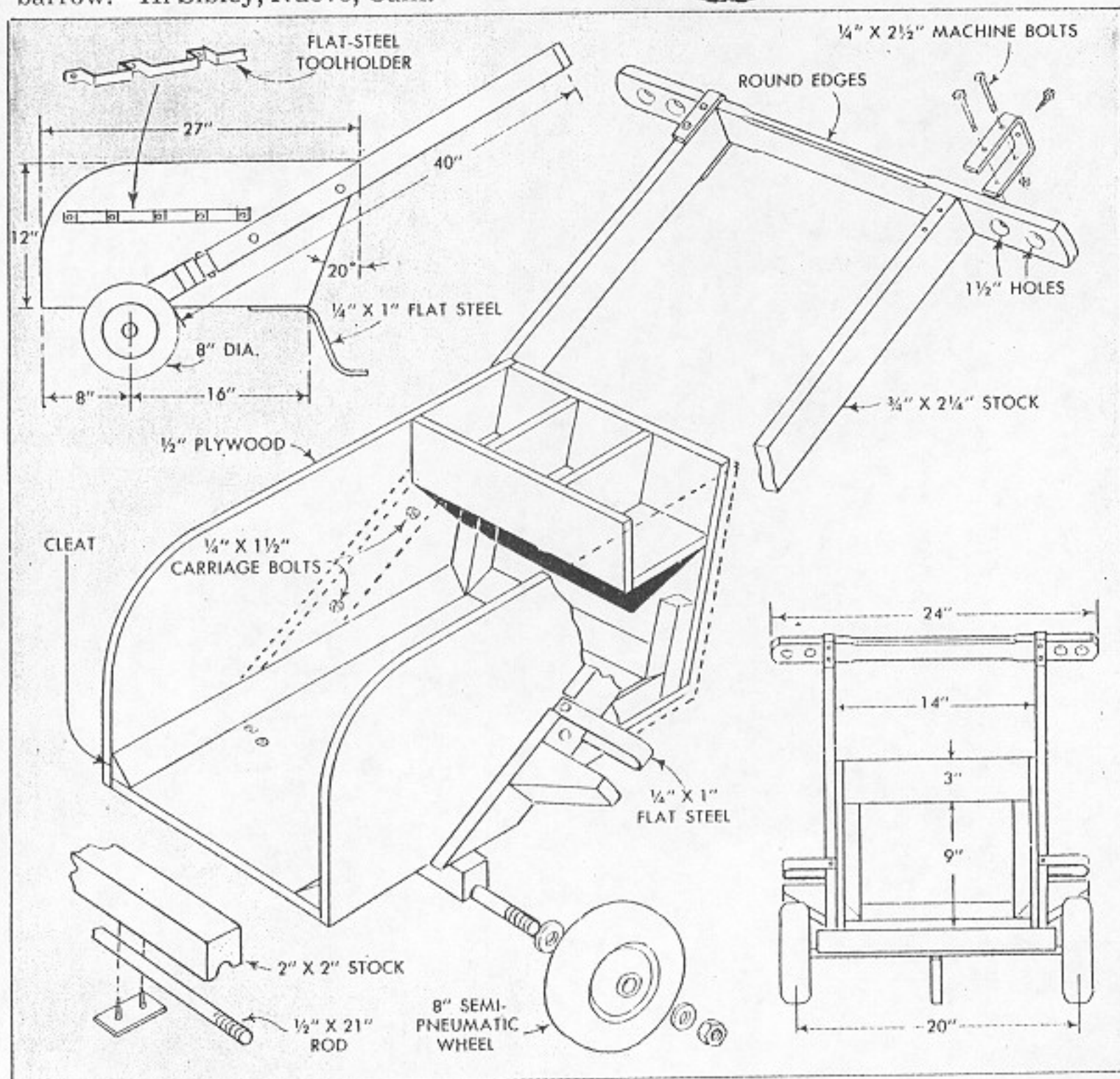


CONSTRUCTION features welded joints throughout. The use of cutting torch in shaping angles and "drilling" holes simplifies work

ALL-PURPOSE GARDEN BARROW

Popular Mechanics April 1952

THIS handy garden barrow will help eliminate the necessity of numerous trips back and forth from the garden to the garage to fetch various garden tools as the need for them arises. Wheeled along easily on two 8-in. semi-pneumatic tires, the barrow accommodates several long-handled tools, such as rakes and hoes, and has a convenient rack for carrying a number of small garden tools. The body, which contains compartments for seeds and bulbs, has plenty of room for carrying bags of fertilizer or grass seed, humus, plant clippings or hose. The body is constructed from $\frac{1}{2}$ -in. waterproof plywood. The axle is held in a groove cut in a 2 x 2-in. block attached to the underside of the barrow.—Hi Sibley, Nuevo, Calif.



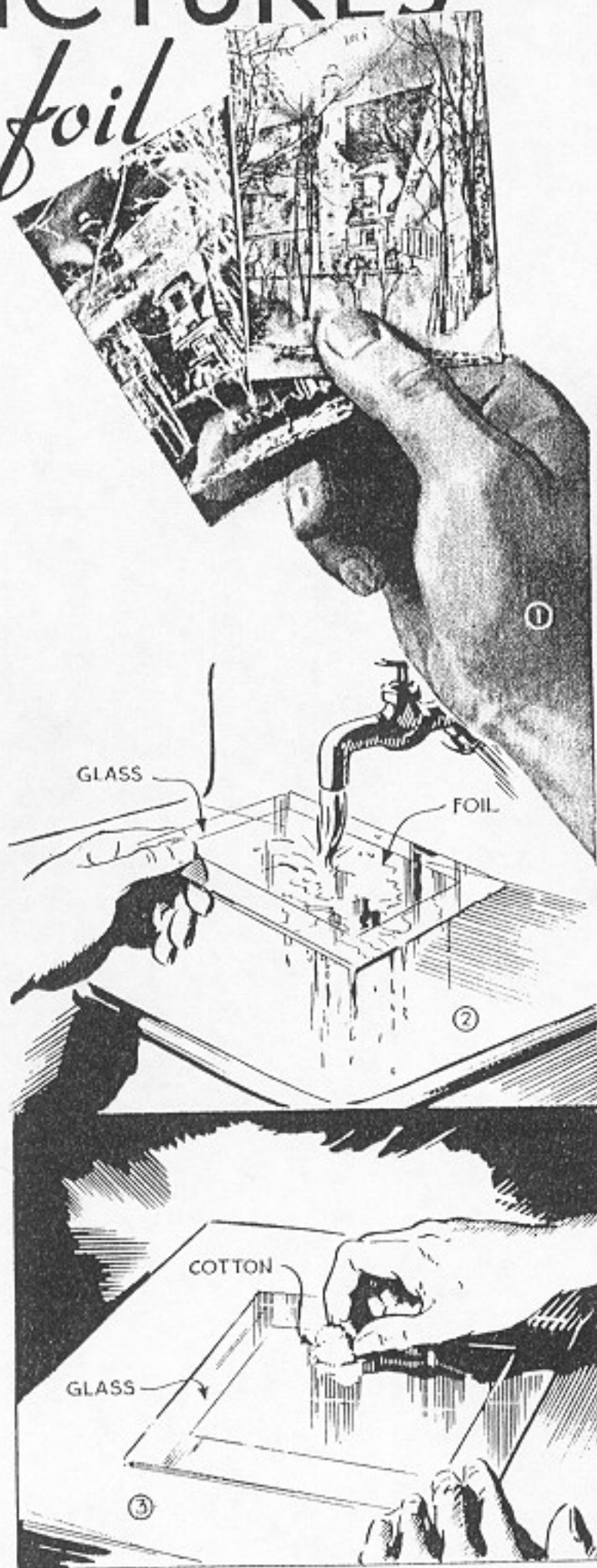
PRINTING PICTURES *on aluminum foil*

By James G. Zimmerman
Popular Mechanics June 1938

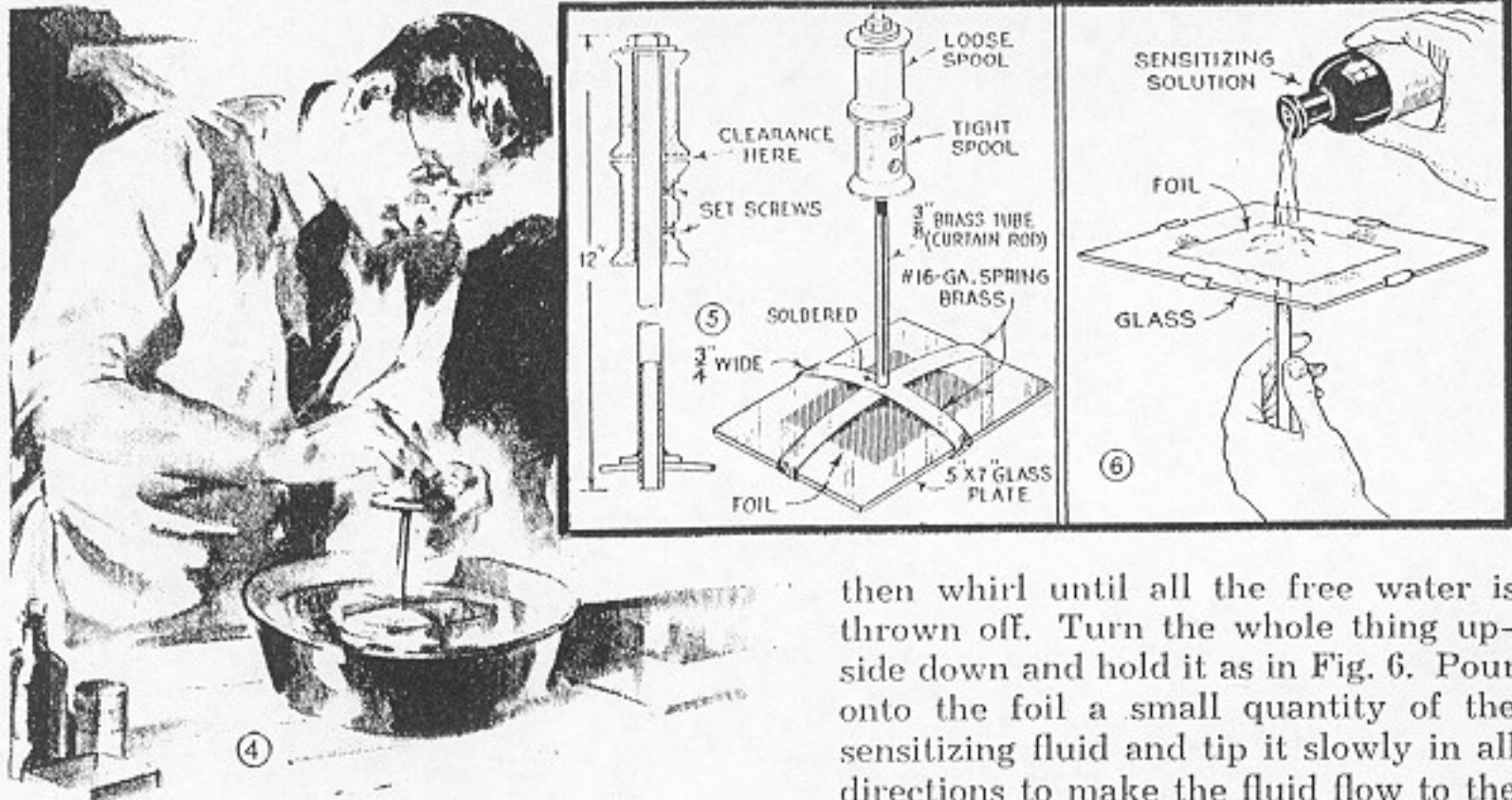
THIS simple process offers possibilities for novel personal treatment of holiday greeting cards, besides making color prints of your favorite negatives on metal foil instead of on the ordinary printing papers. As you will see from Fig. 1, the finished prints appear much like hand-wrought etchings with the added variety of color.

The first step is a thorough cleaning of the foil. To secure a good surface for the sensitized coat to follow, the foil is laid flat upon the larger glass plate after being sure that there is no dirt between the foil and glass, Fig. 2. A good way to be sure of this is to hold the glass under running water while applying the foil. The water will wash away dirt and will allow the foil to rest on the glass with a wet surface between. Drain and then lay flat. Polish the foil vigorously with a tuft of cotton and whiting by holding the foil with the edge and rubbing away from the fingers holding it down, Fig. 3. Repeat in all directions holding at different edges. The foil will gradually take on a silvery finish of a matte nature. This is the grain that is wanted to act as a hold-down for the sensitized film. Give a good rinsing while rubbing lightly with a clean cotton tuft.

An arrangement for whirling the foil dry is shown in Figs. 4 and 5. It consists of two large spools and a piece of hollow brass curtain-rod tube with two $\frac{3}{4}$ -in. wide No. 16 gauge brass strips. The rod is of $\frac{3}{8}$ -in. diameter and fits the spool bore. One spool is loose to allow of turning the rod in it and the other is fastened to it either by screws or glue. The upper loose spool serves as a handle and the lower one is caused to turn by spinning it with the other hand. The two brass strips are made of sufficient length to take the plate used. For example, an old 5 by 7-in. glass plate is convenient. The strips are placed at



right angles and drilled with a $\frac{3}{8}$ -in. hole at their corners. Then these strips are soldered to the tube and bent into a part circle or arc and the tips bent to take the glass with a small overlap. A washer is



soldered above the top spool to act as a thrust bearing against the spool head where a flat metal washer is placed to make a bearing which may be lubricated. After applying the foil of aluminum on the glass plate by simply wetting the surfaces and draining sideways, the glass is sprung into the clips with the film faced outward or downward. When the spool is rotated, the plate whirls with it. Hold the upper spool in one hand and whirl with the other hand.

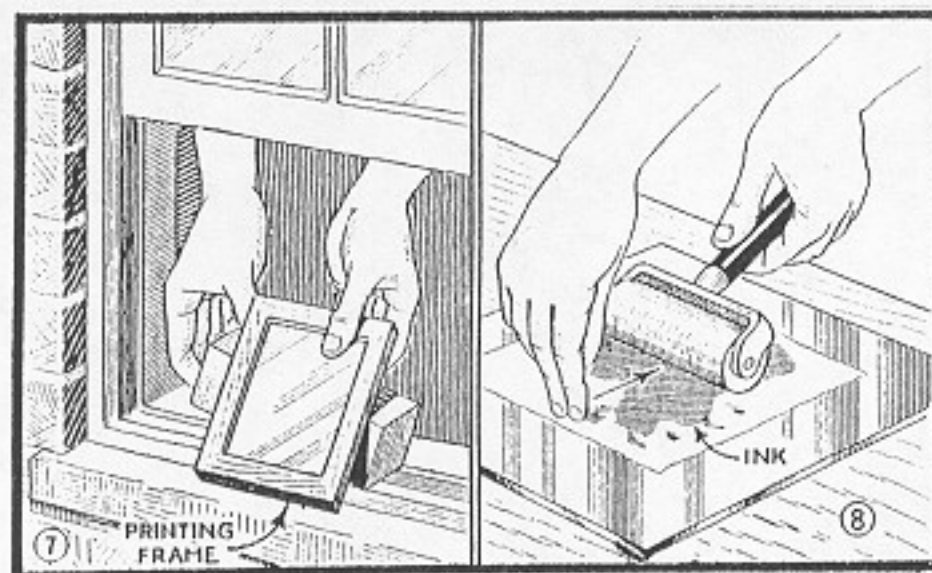
Next, you prepare the sensitizing solution. Beat the whites of two eggs to a very stiff froth in a bowl as in Fig. 10, and set aside for about four hours. The froth will give up a liquid which settles to the bottom of the bowl. Pour out this liquid without disturbing the froth, and mix it with the same quantity of clean water, preferably boiled and cooled. Add about 4 grams of ammonium dichromate (or potassium dichromate) and dissolve it. This will give a reddish yellow fluid. Now, very carefully, add ammonia, drop by drop (ordinary household ammonia will do), and watch the solution after each drop is thoroughly mixed in. It will gradually turn to a lemon yellow. Then it is ready for use. Filter the solution through a cotton wad in a funnel. Wet the wad and then use, otherwise it will not work well. The filtered solution is now ready to use on the plate in the whirler.

Hold the foil under the tap to wet it,

then whirl until all the free water is thrown off. Turn the whole thing upside down and hold it as in Fig. 6. Pour onto the foil a small quantity of the sensitizing fluid and tip it slowly in all directions to make the fluid flow to the edges of the foil and so cover it entirely with a thin coat. Continue the tipping for a few minutes, drain off at one corner, and then whirl to throw off any excess. Apply a second coat in the same manner as before. This time it will be noted that the fluid is more tacky than it was. Whirl at about 50 r.p.m. over a heater to dry the coat. Be very careful not to heat higher than can be stood by the hand. Try this before coating until the proper distance from the heater is found. When dry the foil is ready for printing. Remove with a penknife and clean the back of moisture.

Keep the foil dry and print in the usual printing frame under a vigorous negative. If you have no arc light, print in the sunlight, Fig. 7. It requires experience to know just when to stop printing but if the negative is very contrasty this is not so important. In full sunlight it will take about 5 min., and 1 ft. from a 10 amp. arc light it will take 2 to 10 min. A good way is to take a coated foil without any negative and print by steps, giving the print exposures of 2, 4, 6, 8 and 10 min. by holding a mask over the frame and advancing it a space at a time. Then proceed with the inking up and find which exposure is best for clear open spaces on a negative. An experiment with a negative will show the proper exposure. Label the negative with the proper exposure for future use.

To ink the print, place it, face up, on a dry piece of glass. Now, on another glass plate roll up a pea-sized drop of printers'

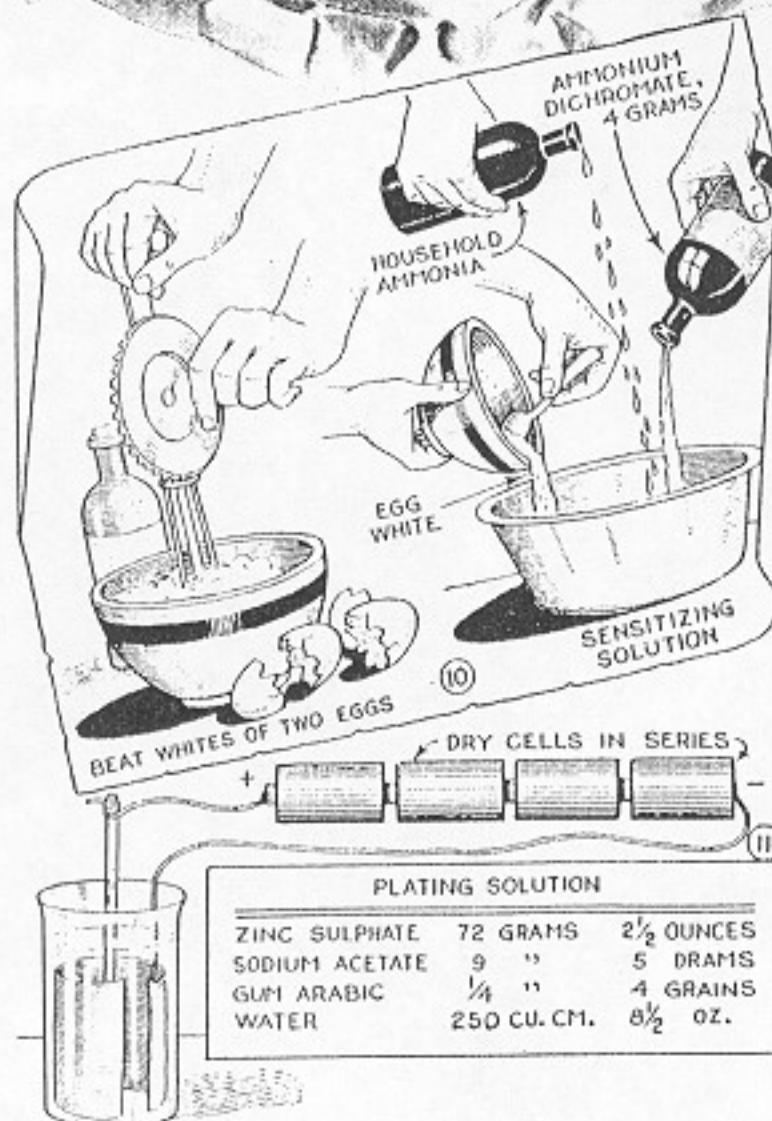
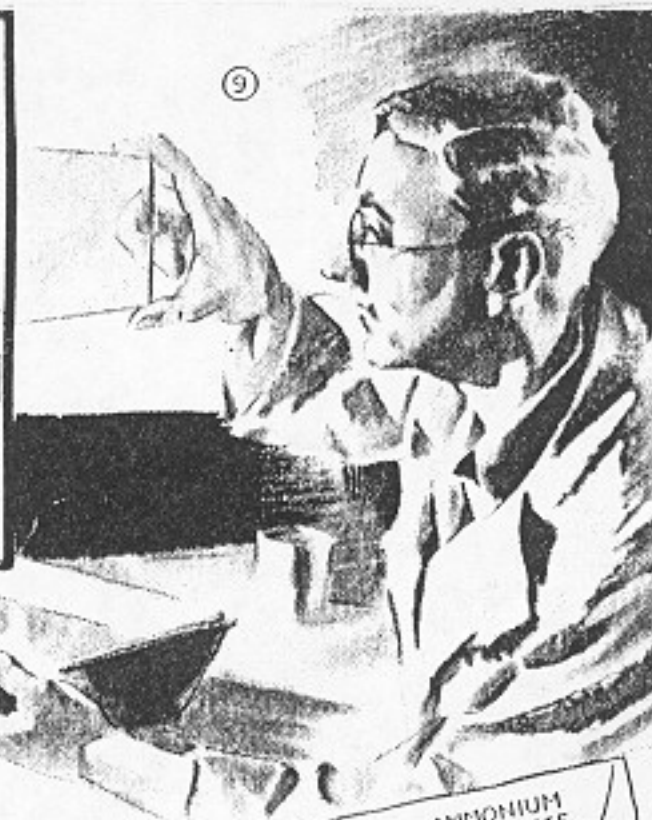


ink until the roller is evenly coated and the plate evenly spread. It is necessary that the ink be not too sticky or when rolling the print the foil will stick to the roller. It is best to start with a rather slippery ink and add a drop of kerosene or linseed oil. Now, holding the foil with the edge by a finger, roll away from the finger and repeat in the opposite direction, holding at the other edge, Fig. 8. After a number of rollings the ink will become darker.

Take the glass plate and foil together and immerse into a deep tray of water, Fig. 9. Do not touch the surface with the fingers at any time. Leave under water a few minutes. The picture will at once begin to show and after the proper time lift the plate out with the foil on it. Wet a tuft of cotton and while the print is under water or under the tap lightly rub the surface. The surplus ink will immediately rub off, leaving the print in full detail. Be careful not to rub too strongly, especially at first, in order not to destroy any detail. If the exposure was too long the ink will adhere more strongly and will require more vigorous rubbing.

If it is desired to add color to the ink this may be done by first whirling the foil to dry it. Then the plate and print are cleared of all water or dampness by letting stand on edge or going over it with a damp cotton, lightly touching any damp spots. When dry the ink is still tacky and will take on any powdered color which is simply sprinkled lightly over the surface and dusted with a camel's-hair brush.

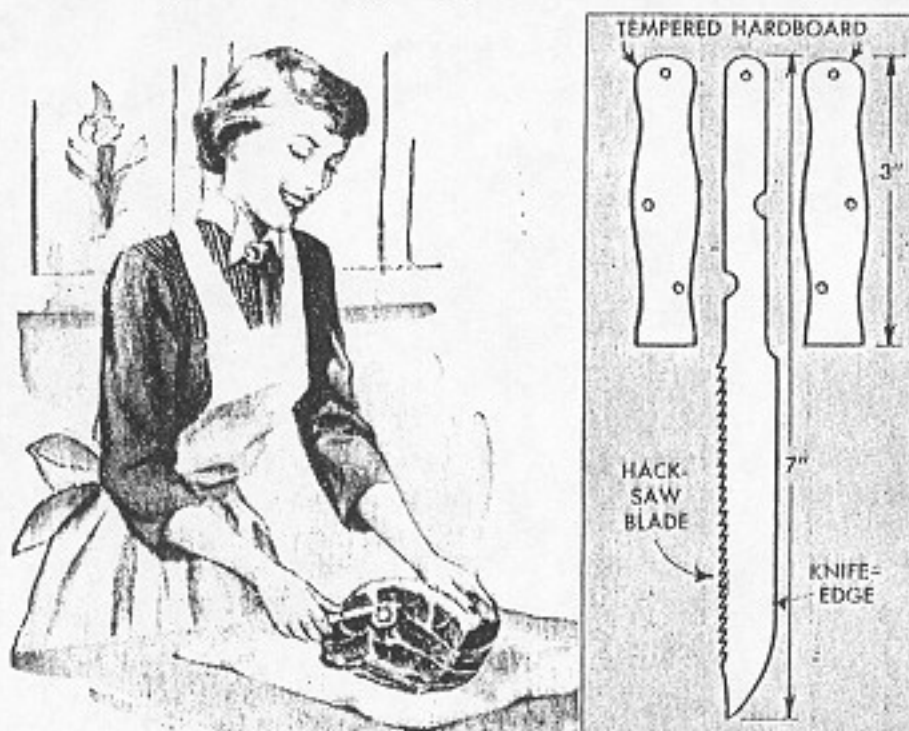
As aluminum foil is rather shiny it's a good idea to plate the print with a thin coat of zinc. The plating solution, Fig. 11, is easily made and keeps well. To dissolve gum arabic, first pulverize it in a mortar



and work it into solution with a little water. To plate, proceed as in Fig. 11. Wrap the finished print around a bottle or other cylinder with the printed face turned inwards. Then pour in the solution up to the top edge of the foil and finally hold the zinc strip in the center. The zinc plates only where the foil is exposed.

As the foil is not rigid it must be mounted on a firm backing like a photo mount. The print must be fastened to the mount with glue, as paste is not satisfactory.

Kitchen Knife Fashioned From Hacksaw Blade Handy for Peeling Vegetables and Sawing Bone



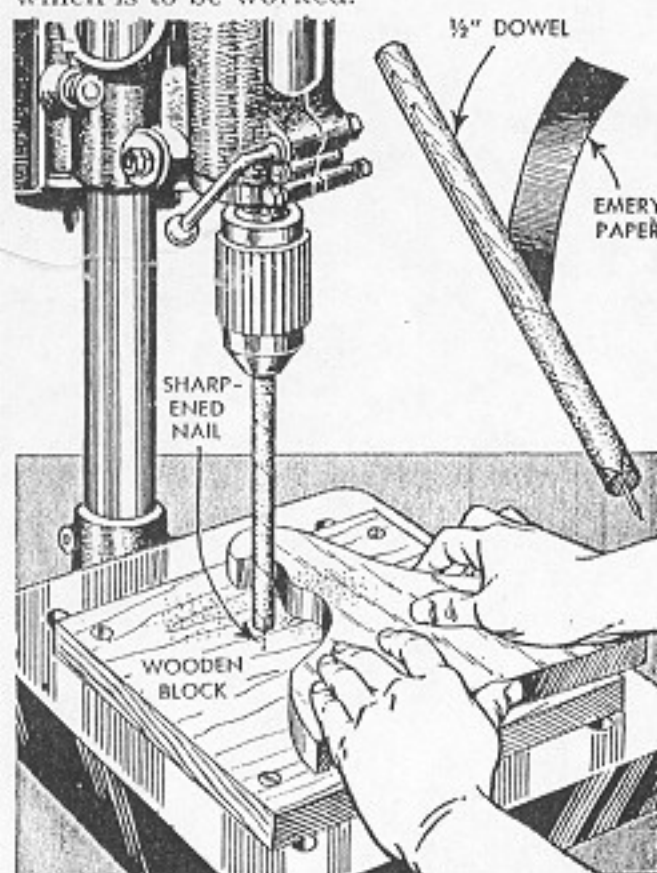
A real timesaver, this kitchen knife has both a keen cutting edge for vegetables or meat and a sharp, saw-tooth edge for bone and gristle. The knife is ground from a hacksaw blade and fitted with a handle of $\frac{3}{4}$ -in. tempered hardboard. A piece of hardboard is cut to fit each side of the blade and registering holes are drilled through both pieces to permit riveting them together. The edges of the hardboard are rounded and the ends of the rivets are ground flush with the handle. Finally, the crack between the handle sections is filled with plastic wood and the handle is shellacked. — J. Harley Hosack, Hartford, Conn.

Popular Mechanics Feb. 1950

Dowel Wound With Strip of Sandpaper Provides Efficient Spindle Sander

For removing saw marks and truing the edges of fine fretwork and small curved parts such as shelf brackets and ornamental scrolls, there's nothing quite as handy and efficient as a spindle sander chucked in a drill press. It is easy to make sanding spindles of varying radii by using ordinary dowels of different diameters up to $\frac{1}{2}$ in. Simply cut 6 to 8-in. lengths from the dowel rods, and drive a $1\frac{1}{4}$ -in. brad into one end of each length. Cut off the head of the brad and point the end. Then cut strips 1 in. wide and 8 to 11 in. long from fine emery cloth. Apply glue to the cloth back of each strip, wind it spirally around the dowel, and wind cord over the abrasive strip to hold it tightly in place until the glue sets. To use the spindle, insert the upper end in the drill-press chuck and tighten the jaws lightly. Clamp, or bolt, a square piece of

stock to the drill-press table and lower the spindle until the pointed brad is forced into the wood, then lock the spindle. The brad provides a bearing for the lower end of the sander. For sanding inside fretwork, just lower the sanding spindle within the area which is to be worked.



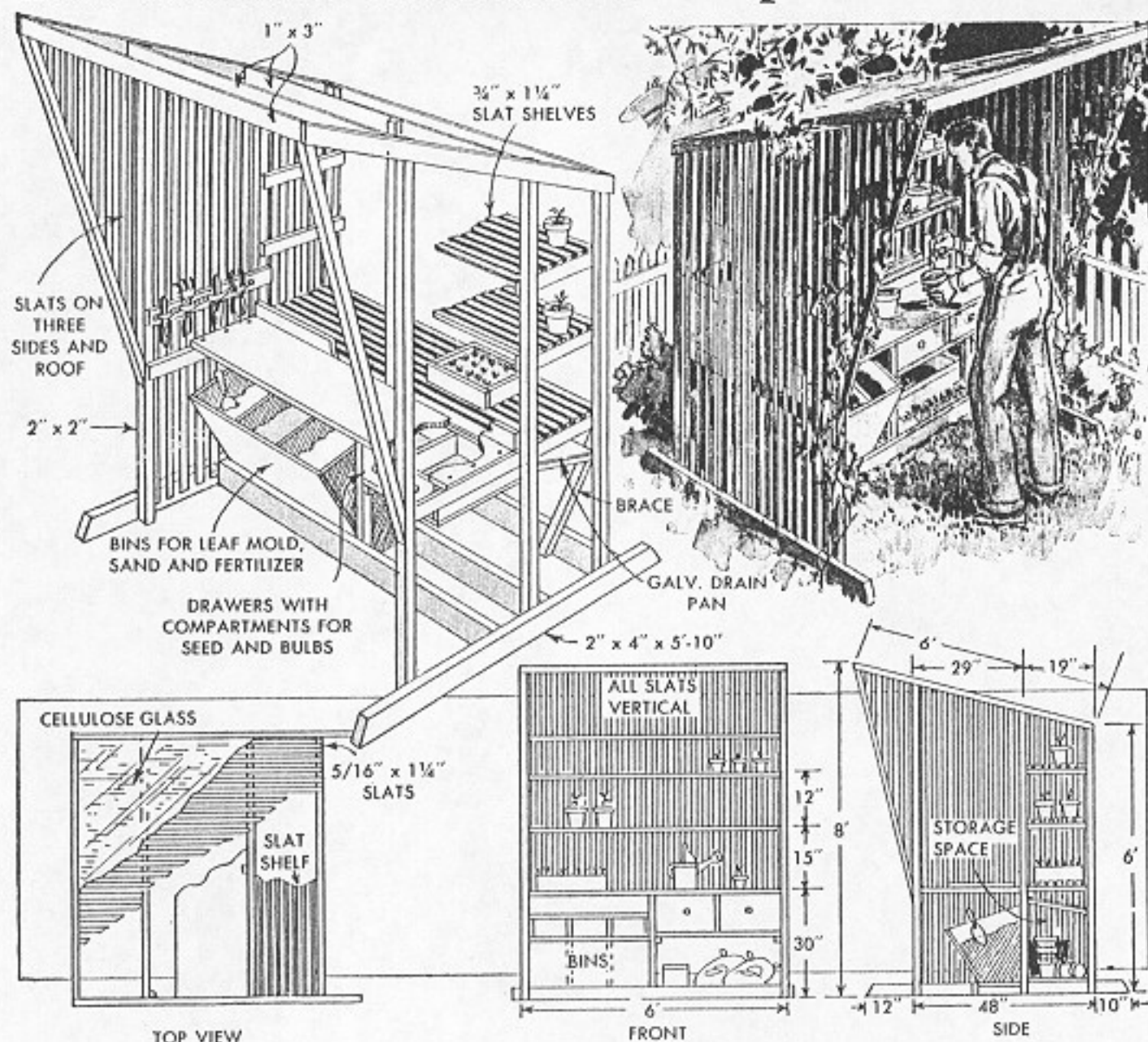
Nighttime Decoration in Room Made With Luminous Paint



An unusual nighttime decor for a game room, study or child's bedroom may be inexpensively done with hand-cut stencils and luminous paint. Barely noticeable during the day, figures stenciled with this paint will glow in the dark. The motif illustrated was used in a child's bedroom, the stencils depicting the moon and stars in a night sky. Other rooms, of course, would be decorated according to their use with many unusual effects being possible.

Mrs. Andrew Naby, Geneva, Ohio.

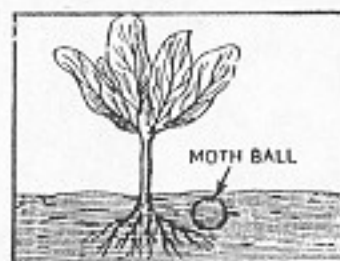
This Portable Lath House Helps the Gardener



Tender young plants that require partial shade until they are sturdy enough for transplanting can be grown successfully in this lath house. It has 27 sq. ft. of shelf space for plants, in addition to a roomy work bench, beneath which are bins for leaf mold, fertilizer, etc., and drawers with compartments for seeds and bulbs. A tool rack is handy at one side, and under the plant shelves is storage space accessible from the rear for flower pots. Construction is simple and cost of materials moderate. The slats should be spaced a distance equal to their own width. If available, cellulose glass can be tacked on the roof slats to prevent heavy raindrops from damaging tender young shoots. If the structure is left on one location for any length of time, excess water from sprinkling the plants will drain away quickly if you provide a 6-in. "floor" of cinders or gravel. Note that under the lowest plant shelf, and just above the rear storage space, a sheet of galvanized iron is installed to drain off drip from the plants above. The open side of the house should face north.

POPULAR MECHANICS AUGUST, 1942

Plants Protected Against Worms By Use of Moth Balls



Destruction of newly transplanted seedlings by cutworms, is prevented by one gardener who buries a moth ball alongside each plant as he sets it out. The ball will not injure the plant, but keeps the worms away.

Auto Casing Serves as Yard Pen And Shelter for Baby Chicks

A large, discarded auto casing makes an ideal yard pen for baby chicks, also providing protection from hot sun, wind

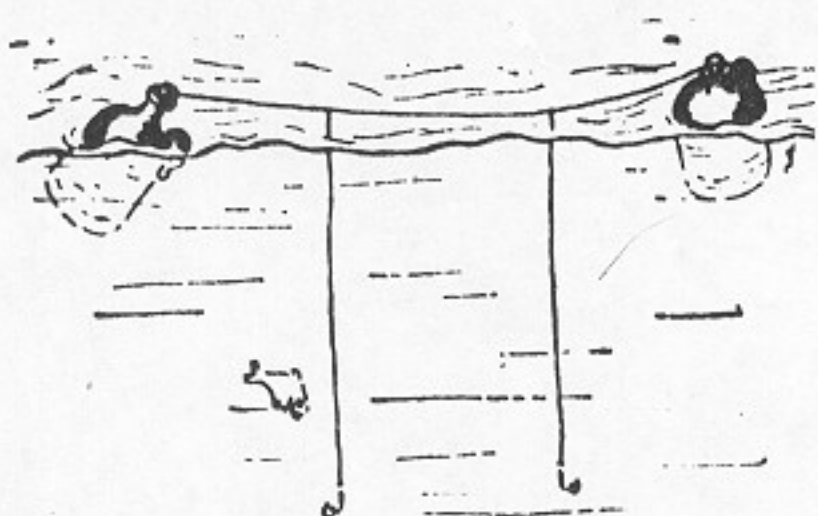


POPULAR MECHANICS.

March, 1904

FISHING TIME COMING SOON.

Fishing time will soon be here and this year you want to have some new and effect-



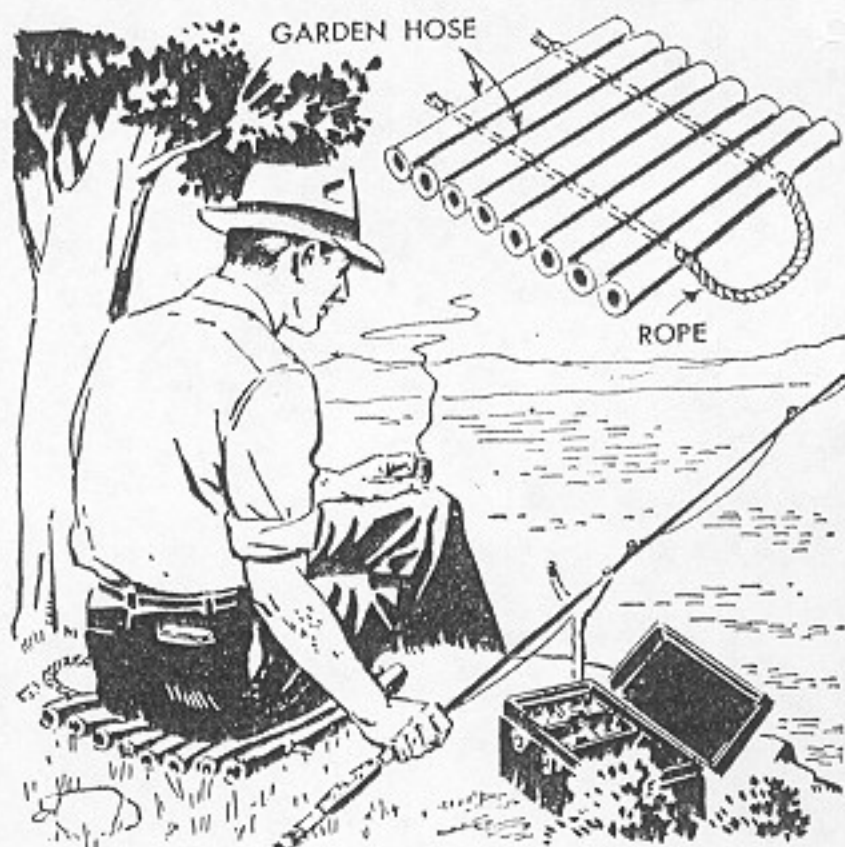
ive methods of catching fish. Popular Mechanics will describe different processes in a later issue, but will tell of the "jug line" now because it is especially adapted for early fishing. Fasten two jugs to a strong line about 30 feet long. Be sure that each jug is securely corked. To the long line attach a couple or more of short fish lines equipped with proper sinkers and baited hooks. This done, place the outfit in the water and watch it, ready to follow with a row boat, or let it float down stream attached to a line held in the hand. When one of the jugs sinks or commences to bobble, you can row out to the line and pull in the fish. On the Mississippi river dozens of jugs are often thus tied together and the fisherman follows them in a row boat until he has a good boat load.

Tube Unit Concentrates Breath When Blowing on Campfire



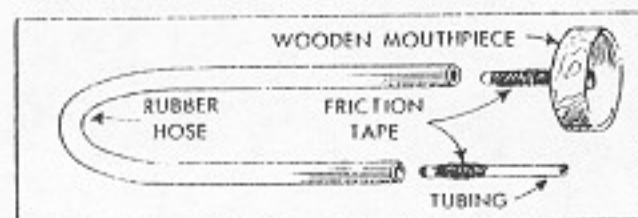
Popular Mechanics April, 1951

Portable Seat for Fisherman Utilizes Old Garden Hose



Several sections of discarded garden hose strung on a length of clothesline provide a portable seat which is just the thing when fishing from the bank of a river or lake. Such a seat is quickly made and, if there is a sufficient amount of old garden hose available, a number of them also will come in handy for picnics. They will be welcome in the early part of the day when the ground is still damp. To make the seats, cut the hose sections to size and drill two holes through each of them. Then, string the clothesline through the holes and knot the ends to form a handle for the seat.

Popular Mechanics Dec. 1951



Finding a bellows too cumbersome to carry on hikes, but wanting a blower to aid him in starting campfires, one boy scout devised this handy "helper." A length of rubber hose was fitted at one end with a short piece of $\frac{1}{4}$ -in. copper tubing and at the other with a wooden mouthpiece as indicated in the detail. Note that in using the blower, the camper need not put his face near enough to the fire to be in danger of burns from flying sparks.

Russell B. Smith, Minneapolis, Minn.

SOLID ALCOHOL (CANNED HEAT)

Mr. Saxon:

Thanks for the article on calcium (Vol. 6, No. 6). The last two paragraphs talk about using calcium acetate to prepare solidified alcohol, commonly known as canned heat or Sterno. Calcium acetate is expensive but I have a process for making it cheaply. The only ingredients needed are calcium oxide (CaO , also called quick lime) available at any building supply store, and acetic acid from vinegar. To extract the water from vinegar, put it in the freezer and remove the ice after it forms. You will then have some pretty strong acetic acid. Now take the acid and quicklime and mix together in a glass container in a 1 to 1 ratio. A white precipitate should form. This is filtered out and dried. After drying, it is ready for use as in the article (reproduced below). The reason this works is fairly simple. Since acetic acid is al-

cohol with an extra hydrogen atom tacked on, the oxygen in the quicklime picks it up. So a tradeoff occurs, creating calcium acetate and water.

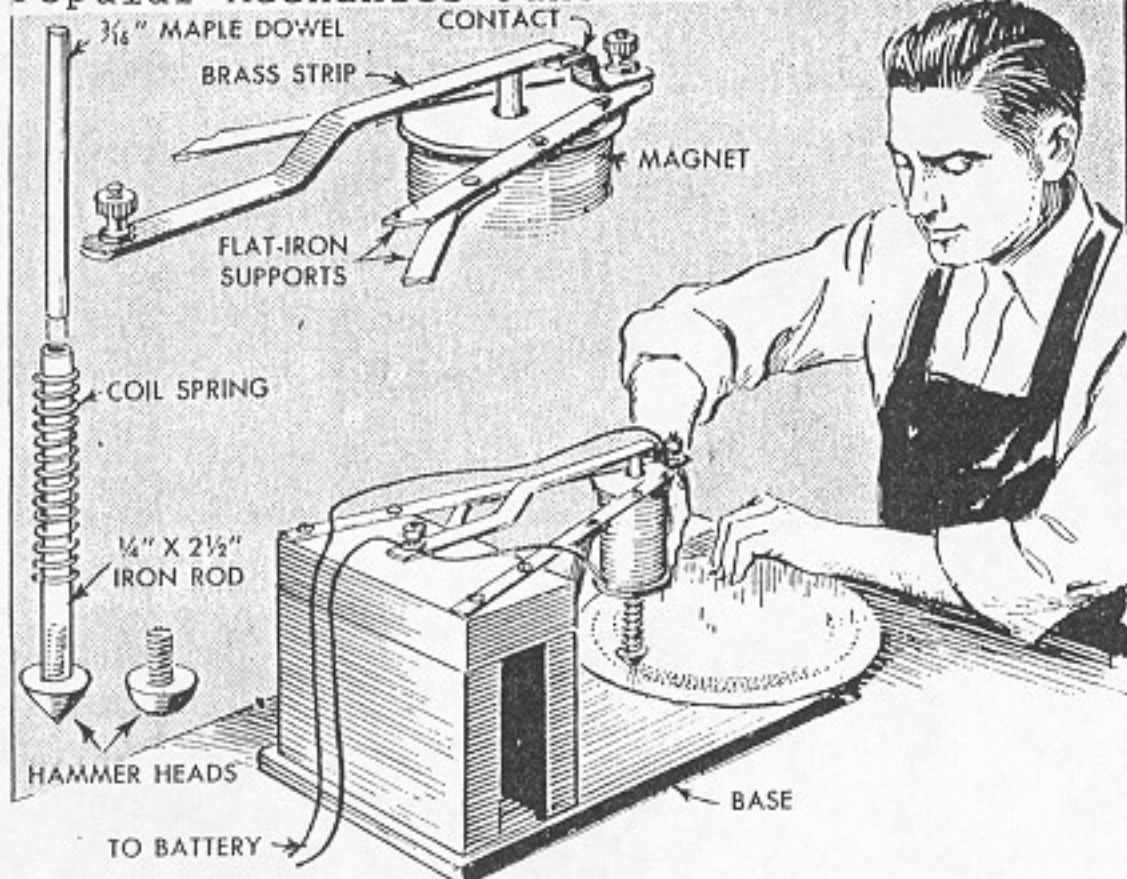
By making use of a curious property of calcium acetate, the home experimenter can prepare a novel form of solid alcohol similar to the jellied substance often referred to as "canned heat." The calcium acetate is made up as a saturated solution by adding the chemical to water until the solution will dissolve no more of the solid. One volume of this solution is added to nine parts of denatured alcohol.

Immediately, a grayish-white jellylike precipitate will be formed. Reaching an almost solid condition, it will remain in the mixing beaker even when the container is inverted. By cutting around the sides with a knife, loosen the mass and place it on the flat tin top of a can or bottle. Bring a lighted match near its upper surface and you will note that the jellied substance will burn with the colorless flame characteristic of alcohol.

With this battery-driven tool you can make hammered ash trays, coasters or other articles of soft metal in only a fraction of the time usually required to do the work by hand. The tool, which features easily interchangeable hammer heads and is inexpensive to construct, may be driven with a 6-volt battery or by 110-volt a.c. through a doorbell transformer. To build the unit, first obtain or turn a wooden spool, approximately $2\frac{1}{4}$ in. in diameter and 3 in. long, and drill a $\frac{5}{16}$ -in. hole through the center. Wind about 15 layers of No. 16 enameled wire on the spool, covering its full length. Then, drill a $\frac{1}{4} \times 2\frac{1}{2}$ -in. iron rod at one end to receive a length of $\frac{3}{16}$ -in. dowel. Drill and tap the other end for a small machine screw, the head of which has been ground to shape for use as a hammer. The spool-and-rod assembly is supported between brackets which are mounted in a hardwood base as shown. A brass strip, which serves as the contact-breaker arm, is fastened to the base by a single bolt and nut. One of the wires from the coil is wrapped around the bolt and held in place with a thumb nut. The other wire from the coil is attached to a terminal bolt on the brass

Electrically Powered Peening Hammer Saves Time When Embossing Metal

Popular Mechanics June 1951

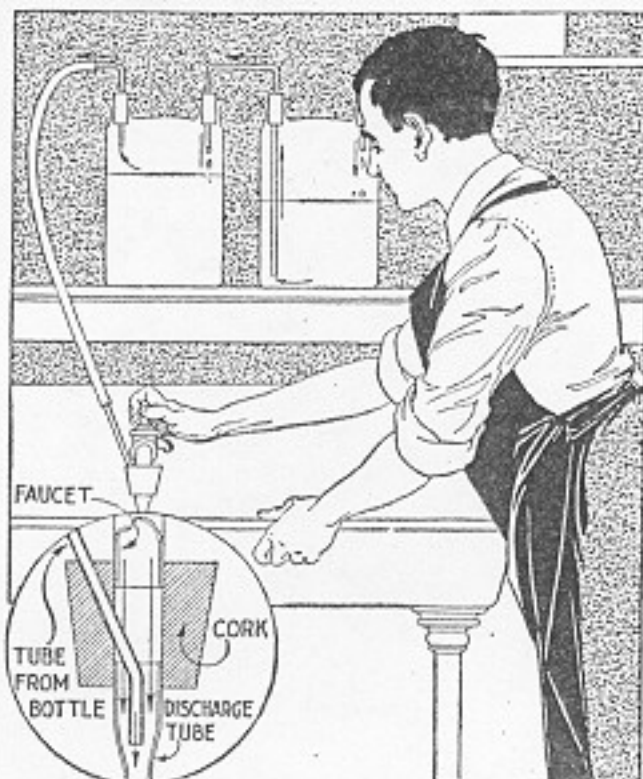


contact piece in a like manner. In operation, the electrical current energizes the coil and causes the iron rod to be drawn upward. The dowel at the end of the rod pushes the breaker arm off the contact point, breaking the circuit. This releases the rod from the magnetic grip, and the spring drives the hammer head against the work. At the same instant, the brass strip drops back on the contact point, thus closing the circuit and causing the sequence to repeat. — R. Morrow, Carrington, N.S.W., Australia.

Laboratory Force Filter

Popular Mechanics 1915

The sketch represents a force filter which is well adapted for use in small laboratories. The water is turned on



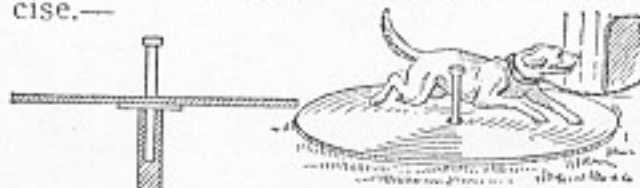
A Slight Vacuum is Formed by the Water Flowing through the Cork, Which Forces the Filter

at the faucet and draws the air through the side tube by suction, which in turn draws the air in a steady stream through the Wolff bottles. The tubes may be attached to a filter inserted in a filter bottle and filtering thus greatly facilitated. The connection to the faucet can be made, as shown in the detailed sketch, out of a long cork, by boring a hole large enough to fit the faucet through the cork and another slanting hole, joining the central hole, on the side for a pipe or tube. At the lower end of the cork a tube is also fitted, which may be drawn out to increase the suction. The inclined tube should be slightly bent at the lower end.

Exerciser for a Chained Dog

Popular Mechanics 1915

The exerciser consists of a disk, 5 ft. in diameter, pivoted in the ground near the kennel. The disk revolves on a $\frac{5}{8}$ -in. pin set in a post made of a 4 by 4-in. piece of timber. The disk is made of common lumber fastened together with battens on the under side. Our dog seems to enjoy this kind of exercise.—



Revolving Disk Exerciser

From For The People, Nov. 30, 1992

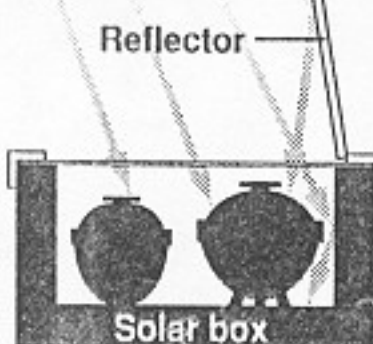
Nature's oven

Solar box cooking is an alternative, inexpensive way to prepare food. Many countries where fuelwood is in short supply are using the method, including India, China, Guatemala and Zimbabwe.

How it works

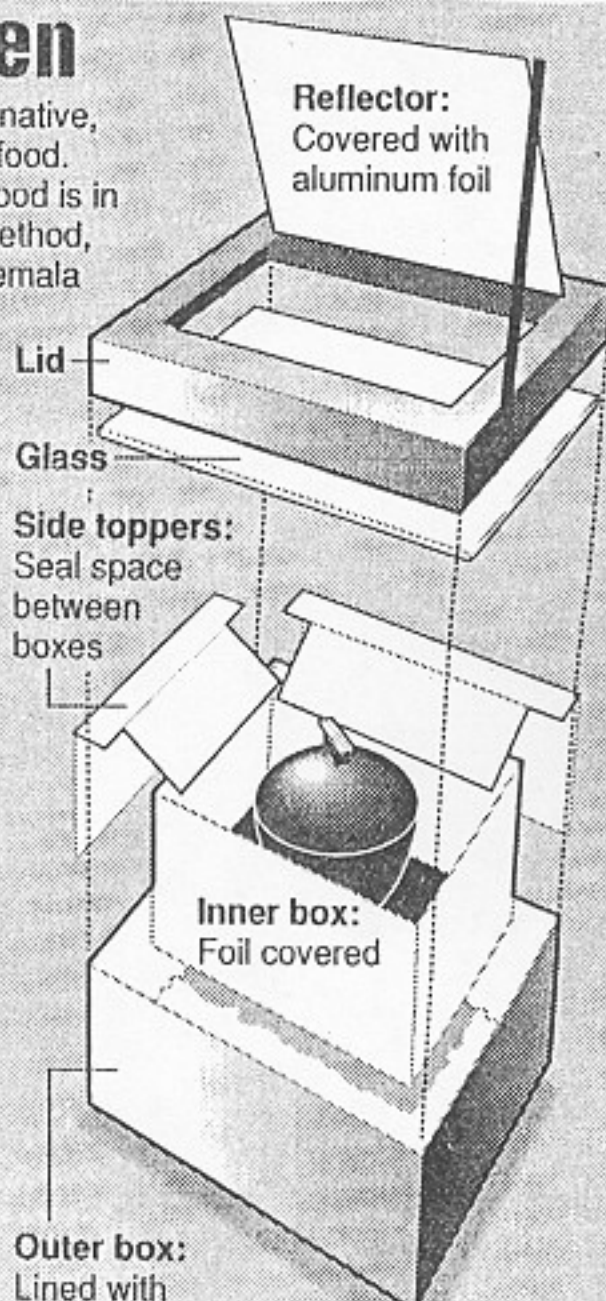
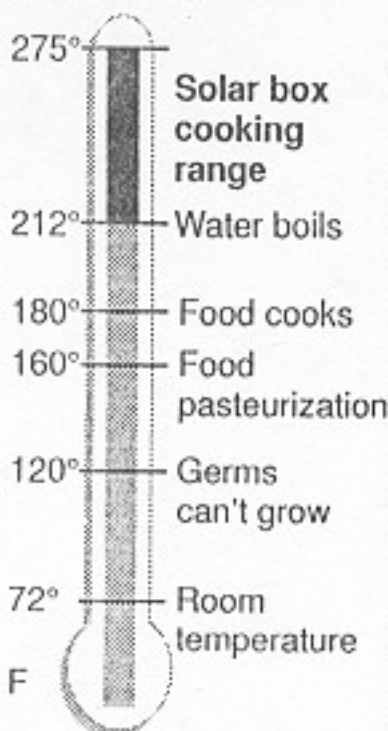
Simple insulated box with lid and glass window is placed facing the sun; can even be made of cardboard

Sun is reflected on aluminum lining, heating up box



Dark, tightly covered pot on dark tray absorbs heat

Cooking thermometer



Outer box: Lined with aluminum foil, holds insulation around inner box



Good for the earth

- Free, renewable energy source
- Saves trees, fossil fuels
- Keeps air clean
- Food won't burn
- Slow cooking preserves vitamins, flavor
- Safe for kids

Cooking times

1 to 2 hours: Egg, rice, fruit, above ground vegetables, fish, chicken

3 to 4 hours: Potatoes, root vegetables, lentils, meat, bread

Tips to cook food fastest

- Cut up in small pieces
- Rotate cooker as sun moves
- Cook during mid-day

SOURCES: Solar Box Cookers International; University of the Pacific; Research by WENDY GOVIER

PEA FLOUR, A NEW FOODSTUFF.

Pea flour, with which the war department has recently been making experiments, will be placed on the market in a short time for general use. Its qualities seem to commend it as a valuable new food product. The flour is to be mixed with wheat flour. It improves the quality of the bread, it is claimed, and causes it to remain soft and moist for a much longer time.

The pea flour, says the American Miller, is prepared for the market by cooking the peas with steam, then roasting them and finally powdering them by roller process. It is extremely nutritious and is said to contain two and one-half times as much of the substance that goes to make muscle and blood as does wheat flour. Nearly 50 per cent of the pea flour is starch and more than 28 per cent is flesh forming element with practically no water.

SUBMARINE BOAT.

A patent has been granted a Bridgeport, Conn., man for a submarine boat the motive power being electricity carried in storage batteries. For travel on the



bottom of the ocean he has provided wheels. When he comes to a nice smooth stretch of sand, by attaching a few teams of seahorses the batteries can be saved for humpy places.

Cigars having the appearance and flavor of the genuine Havana article are made in Chicago out of American tobacco leaf through the aid of the "commercial microbe," a bacteria discovered in real Havana cigars, which is now being nourished on beef tea and raised in Chicago.

Australia has proportionately more churches than any other country, the number being 6,013 or 210 churches to every 100,000 people. England has 144 churches to every 100,000 and Russia 55 to the same number.

PICKLE FOR BEEF AND PORK.

The following is what is called the Pocock Pickle for curing meat, and is considered by those who have followed its directions as much superior to any other method; we venture to say that those who will make trial of it in packing down their meat, will acknowledge that the high eulogiums which it has received are justly merited.

"Take of water, four gallons, the best kind of salt six pounds, salt peter, two ounces, sugar, (or molasses) one and a half pounds; boil these together, and skim off the scum that may rise to the top; then sit it away to cool. The meat being placed in the vessel intended to hold it, pour the cold pickle on it till it is covered. If the meat is to be preserved for a considerable time, the pickle must be boiled and skimmed once in two months, throwing in while boiling, two ounces of sugar and half a pound of salt. This pickle is incomparable for curing hams, tongues and hung-beef. When tongues, and hung beef are taken out of the pickle, they should be cleansed and hung up in a dry warm place. Those who prefer their meat saltier than these proportions will make it, can add eight or nine pounds of salt instead of six. In hot weather, it is necessary, before the meat is put into the pickle, to rub it well over with salt, and let it be two or three hours for the juices to run off.

Another Pickle for corned beef. To six pounds of salt, two pounds brown sugar, and two ounces salt petre, add six gallons of water; boil the whole till transparent, and when cold put it upon the meat which must have been sprinkled with salt a day or two previous.

I have no doubt this 1830 recipe for potato cheese worked. Even so, I've never read of it anywhere else. But if you should work it out and come up with an edible cheese product from milk and potatoes, I guarantee you'd be a millionaire.

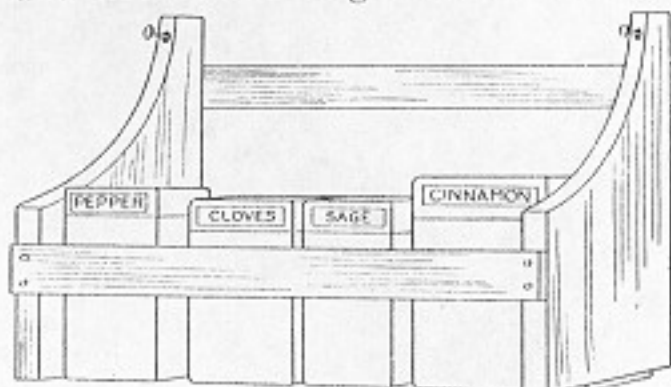
POTATO CHEESE.

In Thuringia and part of Saxony, a kind of potato cheese is made, which is very much sought after. The following is the recipe: select good white potatoes, boil them, and when cold, peel and reduce them to a pulp, with a rasp or mortar; to five pounds of this pulp, which must be very uniform and homogenous, add a pint of sour milk, and the requisite portion of salt; knead the whole well, cover it, and let it remain three or four days, according to the season;—then knead it afresh and place the cheese in small baskets, when they will part with the superfluous moisture;—dry them in the shade, and place them in layers in large pots or kegs, where they may remain a fortnight. The older they are the purer they become.

This cheese has the advantage of never engendering worms, and of being preserved for many years, provided it is kept in a dry place and in well closed vessels.

A Cupboard-Door Spice-Box Shelf

To keep the spice boxes in a handy place where they would be together and not behind larger articles on the



The Shelf will Hold All the Spice Boxes and Keep Them Handy

cupboard shelves. I made a special spice-box shelf, as shown, to hang on the inside of the cupboard door. The shelf swings out with the door as it opens, and is made of two bracket ends to which a bottom board and front crosspiece is nailed. The size of the shelf and its capacity are only limited by the space on the door.

HOW TO MAKE A SUBSTANTIAL FORGE.

Popular Mechanics July, 1902

The farmer or other person in a remote place who wishes to become his own blacksmith can make a cheap and substantial forge in one day, after the following method:

Make a square box of 8-in. board, 2 ft. on the sides, and place legs of convenient length inside the corners. Nail a solid floor on the bottom of the box. In a 2-in. iron pipe, 30 in. long, drill about a dozen $\frac{1}{4}$ -in. holes in a small circle near the center. Pass the pipe through snug holes cut in two opposite sides of the box, leaving it protrude 2 in. on either side. If one end of the pipe is threaded, screw it into fan before running through the box.

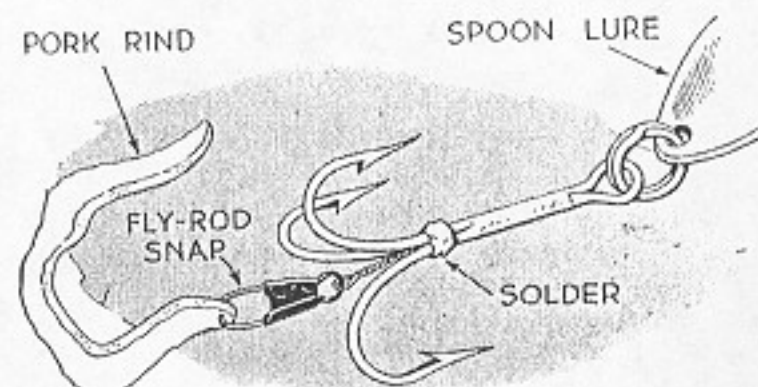
Make concrete of Portland cement, one part, sand three parts, and mix with enough water to make it of the right consistency. Tamp the concrete into the box above and below the pipe, leaving the top sloping toward the holes in the pipe. Put a heavy 4-in. ring around the holes and cement it in. A plug in the outer end of the pipe allows ashes to be blown out when necessary.

The fan should be about 6 in. wide and

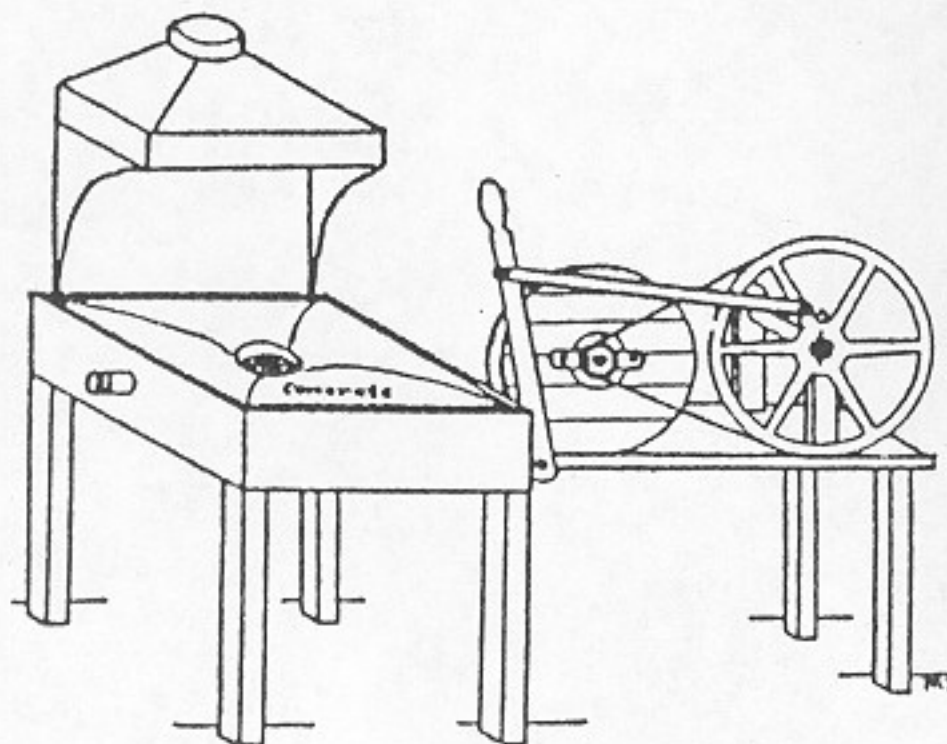
Popular Science

Fastening a Pork-Rind Strip to a Plug or Spoon Lure

FISHERMEN often add attractiveness to a plug or spoon lure by attaching to it a strip of commercially bottled pork rind. To center this so the plug or spoon will weave through the water in a natural way, wire in and solder a small fly-rod snap to the gang hook. The rind can then be attached by the snap.—ROBERT PAGE LINCOLN.



JULY, 1941



A Home-Made Forge

18 in. in diameter, with iron or hard maple boxes and a 2-in. pulley. Mount the fan on the same board that forms the bottom of the forge box, for rigidity. A hood may be suspended over the hearth and connected to the forge back by a strip of sheet iron. When the cement has hardened, a durable fireproof forge is the result. A welding heat can be obtained in one minute with this outfit.—Contributed by Muron Tombaugh, Streator, Ill.

SURVIVOR

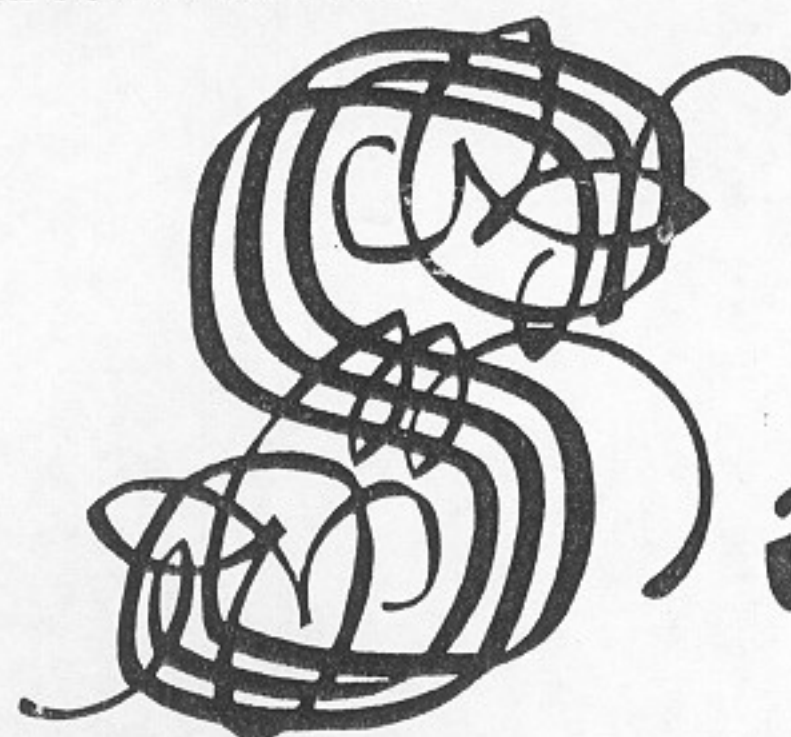
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Silk Screen P R I N T I N G

JAMES EISENBERG

Philadelphia, Pennsylvania

and

FRANCIS J. KAFKA

New York City Public Schools

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Foreword

The silk screen process is a recognized and accepted method of printing which may be quickly and easily mastered. The equipment required is low in cost compared to other printing methods; much of it can be made by anyone able to handle ordinary hand tools. The silk screen process is widely used commercially to print small quantities which would require expensive plates in other methods of reproduction. It is especially adaptable for printing on metal, masonite, and other difficult surfaces, and is very widely used for printing bottles and other containers.

Artistic ability is not essential in silk

screen printing. Beginners will find it easy to master the process and produce excellent work. Ingenuity and originality will come as more experience is gained and as the silk screen printer becomes more conscious of other printing and lettering styles which are adaptable to the job at hand and to silk screen reproduction.

This book presents the steps in silk screen printing. Illustrations are used to a maximum extent, with only a minimum amount of reading necessary. It suggests the tools and equipment necessary and leads the beginner in his exploration of the field.

Silk screen printing is a rich field for the hobbyist seeking an area at once relaxing and profitable. Artist and sign painters will find it a useful addition to their services. Manufacturers and other businessmen may find it useful in preparing streamers, signs or directional devices.

In the schools, silk screen printing offers a rich field. As a crafts activity, it proves immediately interesting and absorbing to students. School events — plays, dances, football schedule posters — will give many opportunities for group projects of several colors and in large size.

JAMES EISENBERG

Chapter 1

A First Experiment

Silk screen printing is a *stencil process*, by which is meant the *withholding* of colors from certain areas on a surface while the color is applied to *other* areas of the surface. Probably the most common form of stenciling is that by which words are stenciled on shipping crates, Fig. 1. The letters or numbers are cut out of thin cardboard or metal. The sheet containing these cutouts is placed against the surface to be imprinted, and paint is brushed through the openings, Fig. 2. Thus, the cut out parts form a stenciled imprint. Early American furniture design was rich in this type of decoration, Fig. 3.

A definite limitation in this method is the necessity of using "bridges" or "ties" to hold the various pieces of a design together. It



Fig. 1. Type of Stencil Image Used on Packages

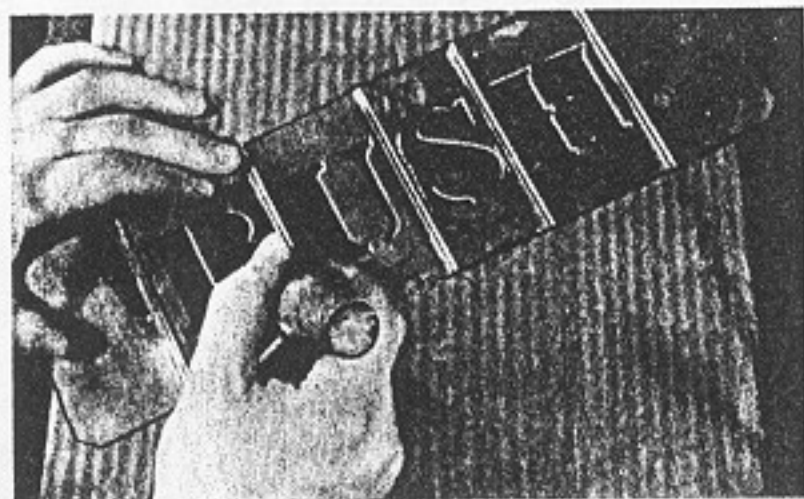


Fig. 2. Paint Is Brushed Through Openings

will be noted in making a stencil of the letter "O", for instance, that the center portion of the letter would be completely detached if it were not for the bridges, indicated by the arrows in Fig. 4. This stencil would not be practical if it became necessary to hold both pieces in place while the paint was applied.

The basic secret of silk screen printing is found in the fabric, or *silk*. By stretching a piece of special silk tightly across a frame there is created a mesh through which paint *will not flow* of its own weight, *but* through which it can be forced with pressure, Fig. 5. Therefore, all that has to be done is to attach to the underside of this stretched silk, the various cut out pieces of the design. When the paint is forced through the silk, it im-

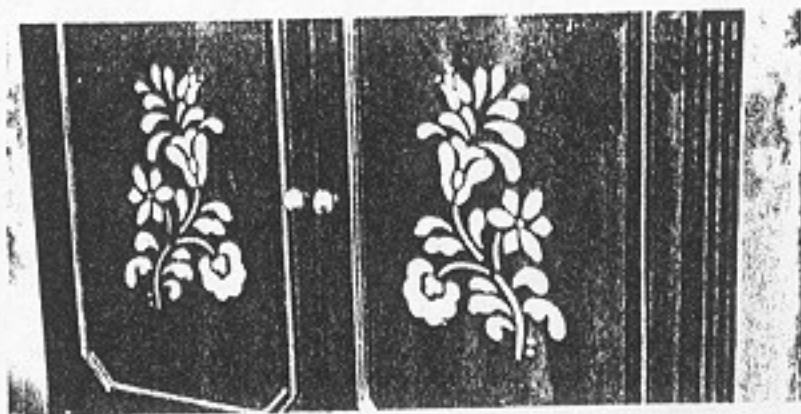
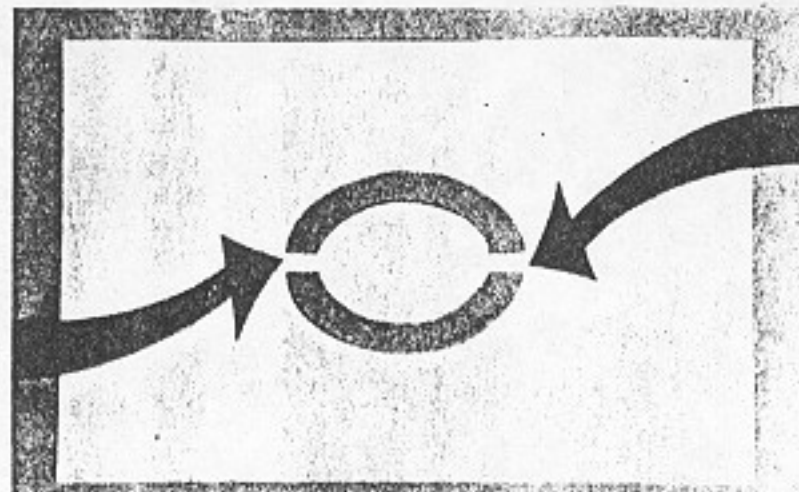
Fig. 3. Early American Stencil Decoration of Furniture
Courtesy, Mr. & Mrs. Lewis M. Mowdy, Berwick, Pa.

Fig. 4. "Bridges" or "Ties" Hold the Design Together

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prints *only* on those areas which are *not* covered by pieces of the design. This method eliminates the use of unsightly bridges which place a restriction on the design.

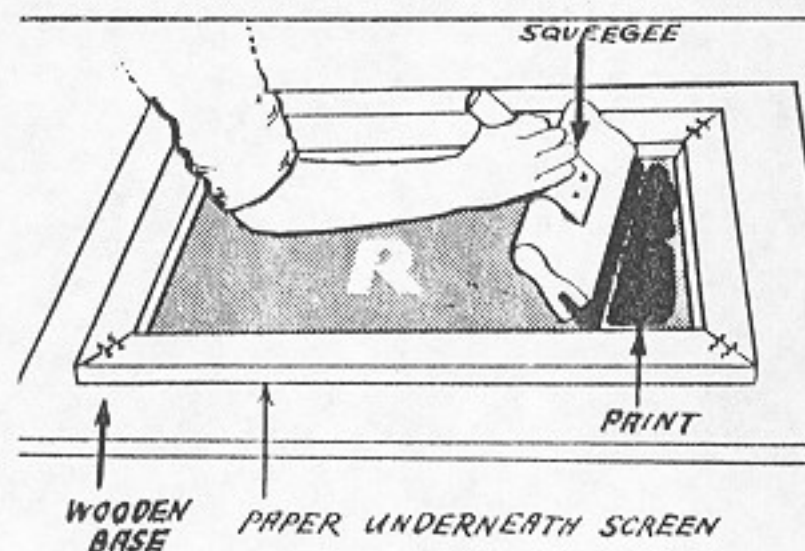


Fig. 5. Force the Paint Through the Screen With the Squeegee

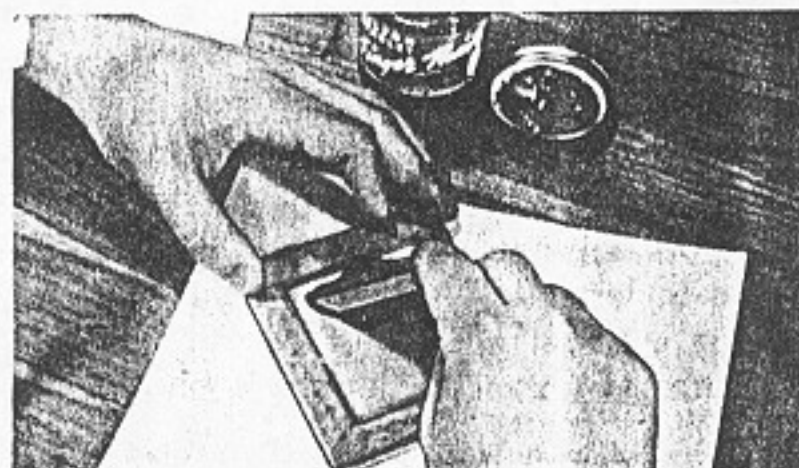


Fig. 6. Miniature Frame in Use

The Experimental Silk Screen

As a first experiment it is suggested that the craftsman make a miniature frame out of cardboard, stretch it with silk, and use a small cardboard squeegee for forcing the paint through a simple monogram design, Fig. 6.

To do this, purchase a half-yard of screen

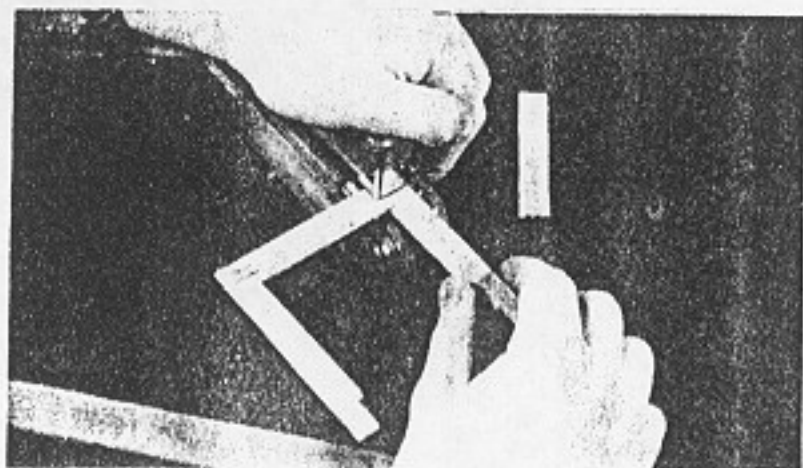


Fig. 7. Staple the Cardboard Strips



Fig. 8. Fasten the Silk

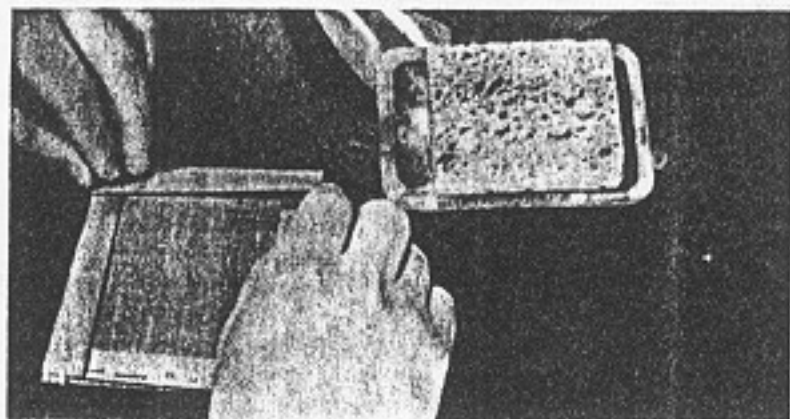


Fig. 9. Cover the Staples

silk or cotton taffeta of the type and mesh size described in Chapter 3. The greater portion of this will be used later. Obtain a piece of heavy cardboard or binder's board, or if this is not available, glue together two sheets of cardboard and allow to dry overnight under light pressure. Cut two cardboard strips 3 inches long and two strips 4 inches long, all $\frac{1}{2}$ inch wide. Shape the ends of the strips with a razor blade as shown in Fig. 7, fit the four strips together, and fasten across the corners with a stapling machine. This will result in a frame, $3\frac{1}{2}$ inches by 4 inches.

Cut a piece of silk $3\frac{1}{2}$ inches by 4 inches. Using the stapling machine again, attach this piece of silk to the frame, stapling first one end, then the other end; then the first side, then the last side. Be sure the silk is stretched tightly and that the "weave" of

the material runs parallel to the edge of the frame, Fig. 8. Cut strips of gummed paper tape the same dimensions as the frame and paste these over the staples, extending

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about $\frac{1}{8}$ of an inch out onto the stretched silk, Fig. 9. Cut a strip of cardboard $2\frac{1}{2}$ inches by 1 inch to use as a squeegee.

Experiment with a pencil and a sheet of graph paper until a desired combination of letters or a monogram is produced, not larger in total area than $1\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, Fig. 10. When a monogram has been chosen, cut a piece of heavy, high-grade bond paper $3\frac{1}{2}$ inches by 4 inches. Using carbon paper, transfer the chosen monogram onto the piece of bond paper, making sure that it is centered perfectly, Fig. 11. Now, using the corner of a razor blade and working on a hard surface (such as a sheet of glass), cut out the complete monogram, allowing the cut portions to remain in place, Fig. 12. When all cutting is complete place the screen frame over the stencil with the fabric side of the frame down. Place a heaping teaspoonful of finger paint or water tempera paint (to which has been added about $\frac{1}{4}$ part of thick laundry starch), in the frame, Fig. 13. Run the cardboard squeegee once or twice across the silk as shown in Fig. 5. This will adhere the entire piece of bond paper to the underside of the screen.

Using the cardboard squeegee, scoop out most of the paint and turn the frame over. Carefully, using the fingernail, lift away all portions of the stencil which are to be printed, Fig. 14. Turn the frame over again, fill the "well" with paint, and using the squeegee print the design or monogram on paper napkins, letterheads, etc.

When the printing is completed, carefully clean the screen with a small piece of

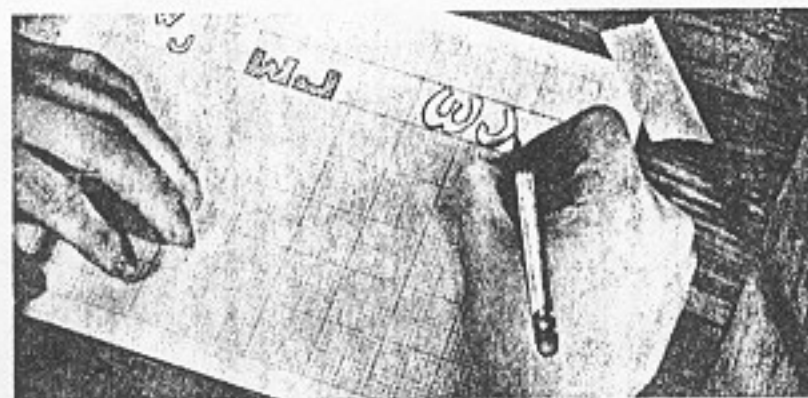


Fig. 10. Design the Monogram

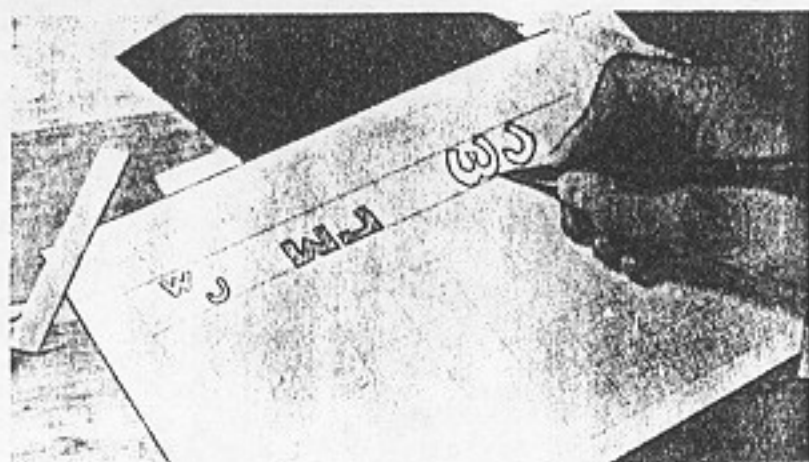


Fig. 11. Trace the Monogram



Fig. 12. Cut the Outline, Leaving Pieces in Place



Fig. 13. Place the Screen Over the Stencil

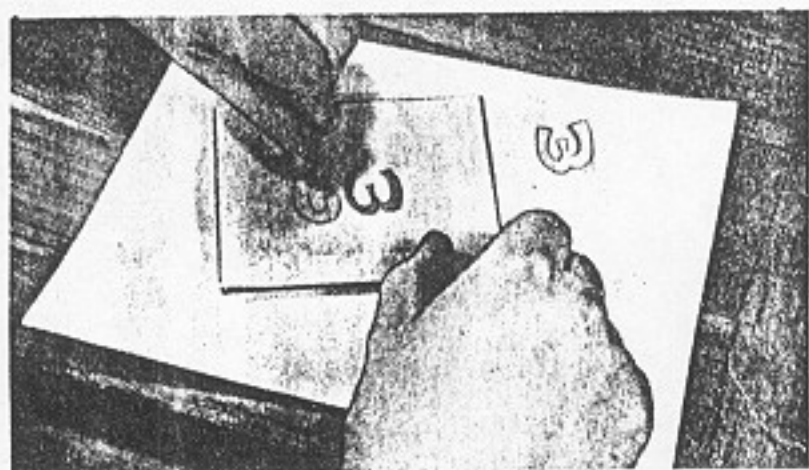


Fig. 14. After Adhering, Lift Out the Printing Areas

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cloth and water. If any portions of the stencil become detached, clean them carefully and save them for attaching again at the next printing. This method does not

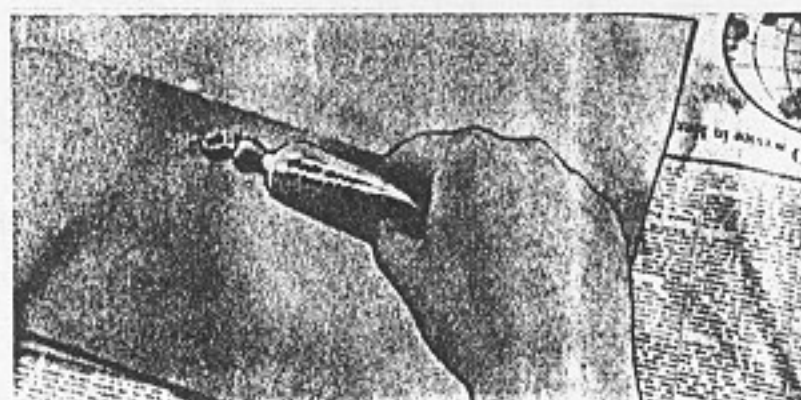
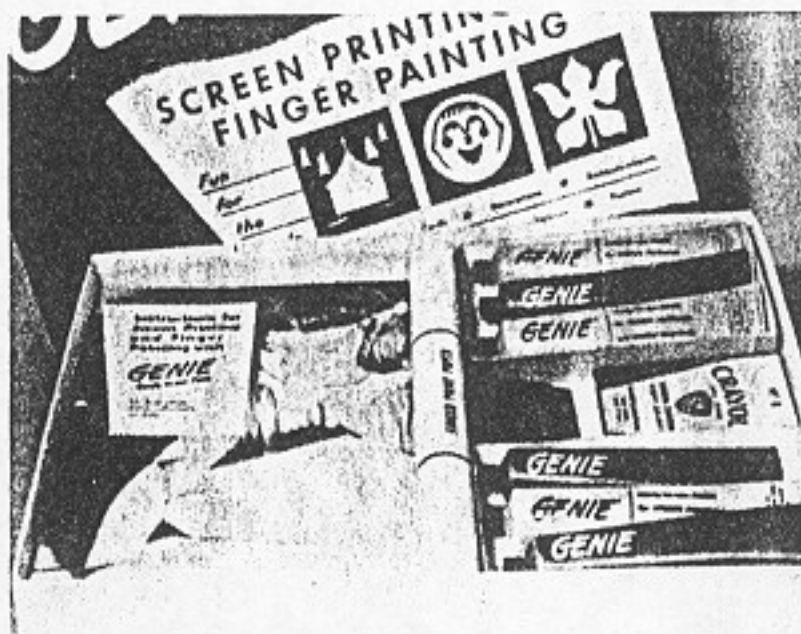


Fig. 15. Finger Paint May Be Used

Fig. 15A. The Complete Genii Kit
Courtesy, Binney & Smith Co.

produce a printing screen of permanent or durable value, but will serve for a quick and inexpensive method of experimenting with this craft.

Finger paint which can be used in this experiment is now available in clear plastic tubes, Fig. 15. In combination with a tube of this paint, the pocket screen actually becomes a portable screening set requiring very little space. It can be taken on trips and it can be used for demonstrating silk screen printing to friends or groups.

Additional Hints

1. Heavy waxed paper or oiled stencil board such as that which is attached to duplicating machine stencils, will prove more durable than bond paper.
2. For longer printings the edges of the stencil can be attached to the screen edge with gummed paper strips, thus preventing paint from seeping under the stencil.
3. For printing on fabrics, a fairly high degree of permanency can be obtained by mixing one teaspoonful of egg white

with three teaspoonfuls of water tempera paint. Add a large dash of vinegar to this and stir thoroughly. After the printing has air dried, it must be heat-set with a warm iron for three minutes. The print is then washable in mild soap and warm water.

4. An excellent kit or set known as the *Genie* is now marketed through art supply stores, Fig. 15a. This set utilizes embroidery hoops as the screen frame and comes with a piece of coarse silk and a piece of fine silk. The silk is held tightly by closing the embroidery hoops over it. The paper stencil method described in this chapter and in Chapter 6 is used with the coarse silk. The set contains six tubes of finger paint, a small rubber blade as a squeegee, pattern designs and full instructions. This technique brings silk screen printing down to its simplest level and yet retains the principles of the craft. This set has been used successfully with six-year-old children.

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Chapter 2

Silk Screen Printing

As described in chapter one, the silk screen process is a stencil method of printing, using a fine porous fabric stretched tightly across a frame. The non-printing portions of the fabric are blocked out and the ink or paint is forced through the screen with a rubber squeegee, on to the printing surface below.

Silk screen is believed by some to be the oldest form of printing. The Chinese and Japanese used it many centuries ago by attaching a cut out design to a thin web of hair and then painting through this stencil. The exact technique is not known but designs were produced which made it possible to eliminate the bridges, or ties, which normally hold together isolated portions of a pattern.

Fabrics

Several fabrics are satisfactory for silk screen printing. Organdy and taffeta are frequently used in beginning classes where cost is a factor. They also may be used in industry when a short run of a simple poster

is to be made. The best material, though, is a finely woven fabric called silk screen bolting cloth. This comes in widths of 40, 45, 50 and 54 inches and may be purchased in any length desired. Three standard grades are available; single X and double X are ordinarily used; triple X is employed where unusual durability is required. Silk screen bolting cloth is also classified according to mesh, with No. 1 the most coarse and No. 25 the finest in weave. For general purposes, a medium fine No. 12 mesh, XX grade is the one most used.

Nylon, dacron, and more recently even wire mesh made of monel and phosphor bronze are also used. These are available in most of the regular mesh sizes. They are superior in tensile strength but are also more costly.

Block-Out Materials

There are also many kinds of block out materials. Paper, glue, shellac, lacquer, specially prepared show card color and various photographic emulsions are in common use. For stencils requiring more sharpness and detail, a film material is used. This film material is available from graphic arts supply houses under such trade names as Profilm, Nu-Film, Blufilm, etc. Photographic films are also available for still finer, more detailed work and halftones.

Use and Importance

Materials printed by the silk screen process are in everyday use. Department stores and factories use many signs and streamers which are reproduced by this process. Beverage bottles for milk and soft drinks are other common items which are silk screened. Directional devices on equipment and on toys; price tags; decals for glassware, machinery, and trucks; greeting cards — these are but a few of the uses of silk screen printing.

Advantages

The silk screen process offers several advantages.

1. *Color.* Because of the density of the pigment, light colors, even white, can be solidly printed over dark surfaces.
2. *Low cost.* A silk screen stencil can be prepared inexpensively, since it is essentially handwork. Perfect art work or

"copy" is not required; minor corrections and changes can be made easily as the stencil is cut.

3. *Versatility.* Silk screen prints on nearly any surface: paper, cloth, cardboard, wood, metal, glass, leather, plastic, etc. Specially prepared water colors, oil colors, dyes, lacquers, glues, waterproof

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poster colors, and enamels may be used to good advantage with the silk screen process.

4. *Flexible size.* The only limit to the size of the printing area is the size of the frame used. Very large stencils may be made, and conversely, very small pieces may be printed.

A Modern Industry

Because of modern advertising demands and the desirability of mass-producing posters, signs, flyers, etc., which have the appearance of being individually hand-made, the industry has become a tremendous one. Many small print shops have added a screen division because it is relatively inexpensive and simple to operate, and it enables the printer to give a more complete service. Chapter 15 gives an overview of this modern industry including recent advances into machine printing, automatic printing and other large production methods.

Stencil Methods

Several methods of preparing stencils are in use. Since silk screen uses varied inks and is used for printing on many surfaces, it is necessary to select the type of stencil which will best do the job at hand. In selecting the type of stencil to be used it is necessary to consider the printing surface, the type of ink, the number to be printed and the copy to be reproduced. Six methods are commonly used commercially.

1. *Paper stencil method.* This method is generally used for large areas with only a few words of copy. It is well suited for printing real estate signs on wood, metal or paper; the popular 28" x 44" one sheet signs; and the billboard poster with an overall measurement of 104" x 234" which is printed in sections.

This method is not recommended for large quantity runs because ultimately the paper stencil becomes saturated with

the printing pigment and often becomes detached.

2. *Tusche and glue method.* Tusche is a form of wax suspended in water but not soluble in water when hardened. When used in combination with ordinary animal glue, it provides a simple method for quick, knock-out show cards for stores. It is also used frequently to simulate a hand-painted appearance, particularly on fabrics. It reproduces dry brush, stipple and crayon drawing techniques. Liquid tusche, or lithographers' crayon (which is tusche in solid form), may be used.
3. *Show card mixture method, for reverse printing.* This method is used where speed is the primary object. It does not give as fine a result as the other methods. The most common use is for inexpensive show cards, window streamers, "bull's-eyes" or "spots".*

* These are small window posters, usually used on store windows, particularly grocery and drug stores. There is no standard shape or size, the message being the determining factor.

4. *Indirect photographic method.* This method reproduces fine lettering, designs, and intricate drawing effects in both line and halftone.
5. *Direct photographic method.* This method also produces fine line work and intricate effects. It has certain advantages over the *indirect method* because a light-sensitive emulsion is coated *directly* onto the entire screen, thus eliminating the necessity for adhering a film stencil or blocking out marginal areas.
6. *Lacquer film stencil method.* This method is used for work demanding neatness and precision. It gives clean-cut edges to lettering and art work.

Most jobs can be reproduced with one method; however, there are jobs for which it is advisable to use a combination of two methods, usually the photographic and the lacquer film stencil. Such combinations are a matter of judgment and require experience with all methods to decide whether combining methods is most suitable. The lacquer film stencil is most generally used.

Chapter 3

Making Your Own Equipment

These directions may be followed to build a unit of any desired size. If the frame is to be more than 12" x 18", its members should be somewhat larger than 1" x 2". The size of the frame will also determine the size of the squeegee to be made.

Tools and Materials

White pine lumber, 1" x 2", kiln dried and free from knots. About twelve or fifteen lineal feet will be needed for individual frames and drying racks.

Back saw, Fig. 16.

Carpet tacks, to fasten fabric to the frame. These are now available in solid copper or solid aluminum. Either kind is superior to the steel variety because steel will rust. The fabric may be attached by using a stapling gun as shown in Fig. 17.

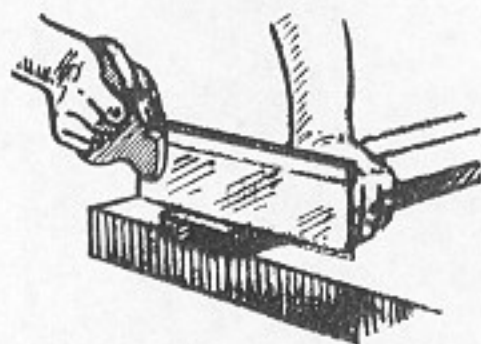


Fig. 16. Back Saw

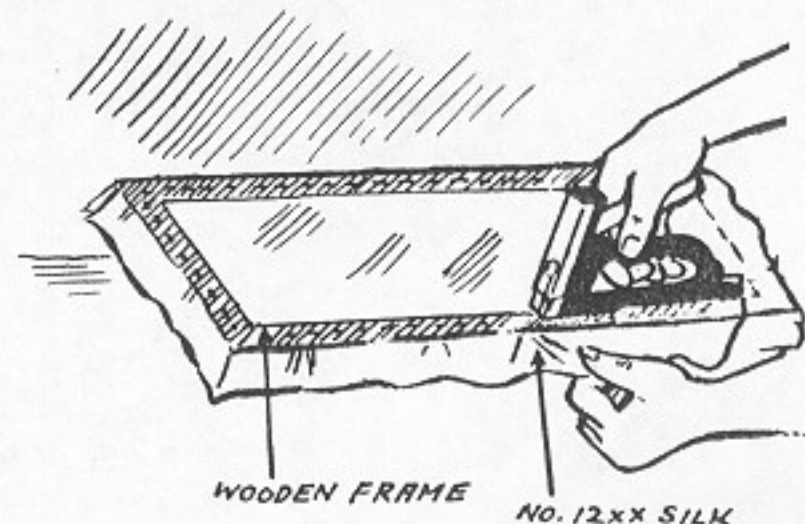


Fig. 17. Fasten the Stretched Silk With Staples or Tacks

Cleats, to join corners of the frame. Two types of cleats in common use in silk screen

work are shown in Fig. 18.

Hammer, used to tack fabric to frame.

Silk screen bolting cloth, No. 12XX. About one yard will be enough to begin work. Organdy or taffeta may be substituted, but the silk is most practical for posters, displays, show cards, etc.

Oval head screws, to attach hinges to frame and base.

Screw driver.

Sandpaper, No. 000.

Loose pin butt hinges, Figs. 19 and 19A. One pair will be needed for each frame to be



Fig. 18. Cleats

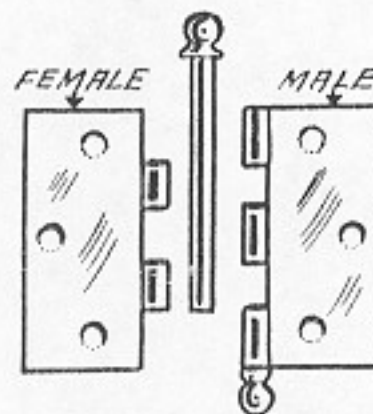


Fig. 19. Loose Pin Butt Hinge



Fig. 20. Single Edge Razor Blade

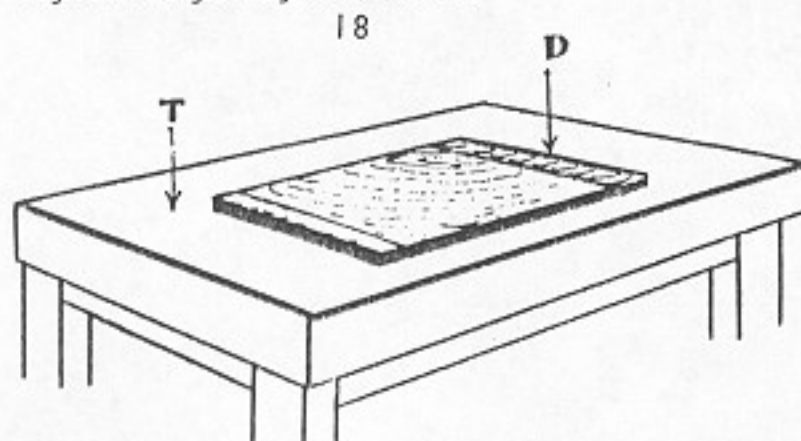


Fig. 21. Wood Base (Drawing Board or Table Top)

made. Note that the halves are designated as male and female.

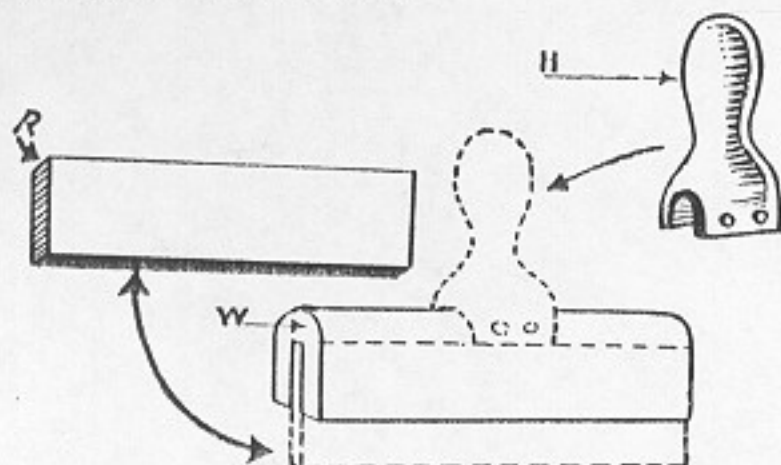


Fig. 22. One-Handed Squeegee
R - Rubber Blade H - Grip Handle W - Wood Housing

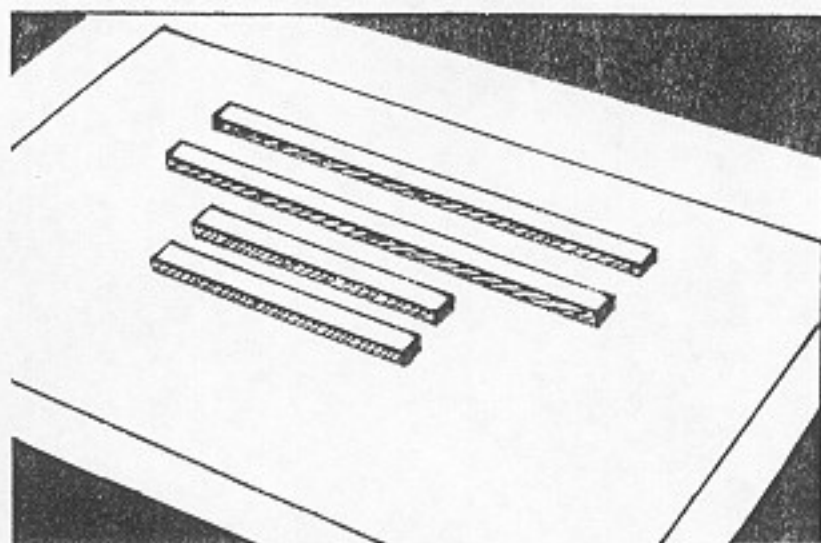


Fig. 23. Pieces for Screen Frame

Single edge razor blade, Fig. 20, to trim excess silk from frame.

Wooden base, to which to attach printing frame, Fig. 21. This may be a drawing board, (D), or the frame may be hinged to a wooden table top (T).

Squeegee, Fig. 22, consisting of a rubber blade sandwiched into a wooden housing.

Shellac, one pint, either brown or white shellac. It will be used to coat the inside and outside taped edges of the screen frame.

Stiff paint brush, $\frac{1}{2}$ " to 1" wide, to apply shellac to frame.

Glue, is used in the making of a stencil as well as in making the screen unit. A pint should be sufficient.

Bowl or can, large enough to mix the "glue solution" (See Fig. 35), about one pint capacity.

Sponge, to moisten the gummed tape with the glue solution.

Gummed tape, 2" width, to seal inside and outside edges of screen and frame, making it water tight and leak proof.

Making the Frame

The frame needs to be rigid in order to support the tightly stretched cloth and the paint. Miter joints may be made and fastened with the cleats, two on the top and two on the bottom. Butt joints may be fastened in the same way. The corners may be reinforced with angle irons on the side or with "L" irons on top. Remember that the larger the frame, the stronger it will need to be.

1. Cut the lumber to the required size, Fig. 23.

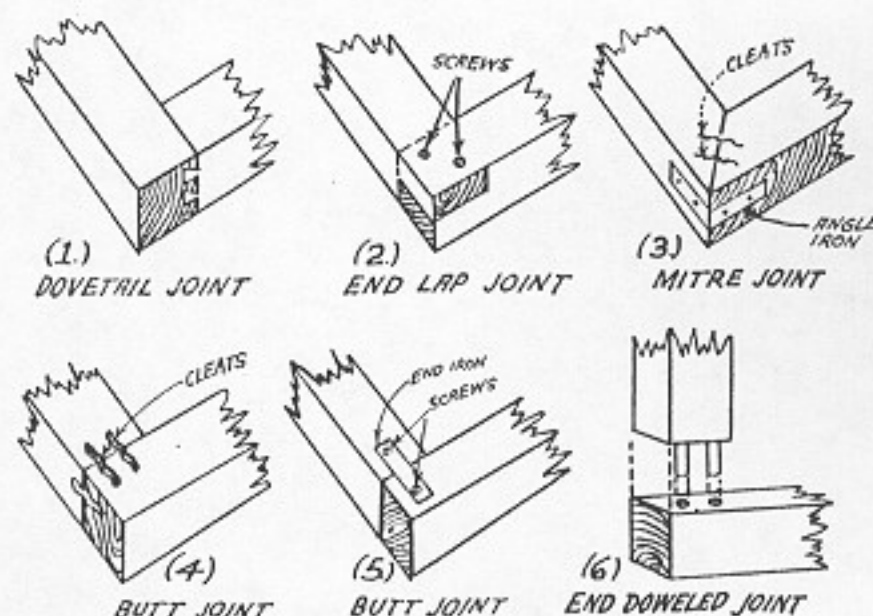


Fig. 24. Types of Joints

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2. Join one long piece and one short piece at a right angle. Use a miter or butt joint or one of the joints shown in Fig. 24. Fasten the pieces together with cleats, Fig. 25.
3. Use angle irons to make the frame rigid. Place them on the outside of the corners and fasten with screws, Fig. 26. If preferred, corner irons may be used as shown in Fig. 27.
4. Sand the front and rear edges of the frame so that they are smooth and slightly rounded, Fig. 28. This will keep the frame from tearing the silk fabric.

Stretching the Silk and Tacking It to the Frame

Cut the piece of silk somewhat larger than the frame, in order to insure it being stretched tightly when applied. Remember also to allow enough silk for "paint reservoir" purposes. Fig. 29 shows the relationship of screen area to size of card "Rent" to be printed. Note the excess space areas of 2" top and bottom and 4" on each side

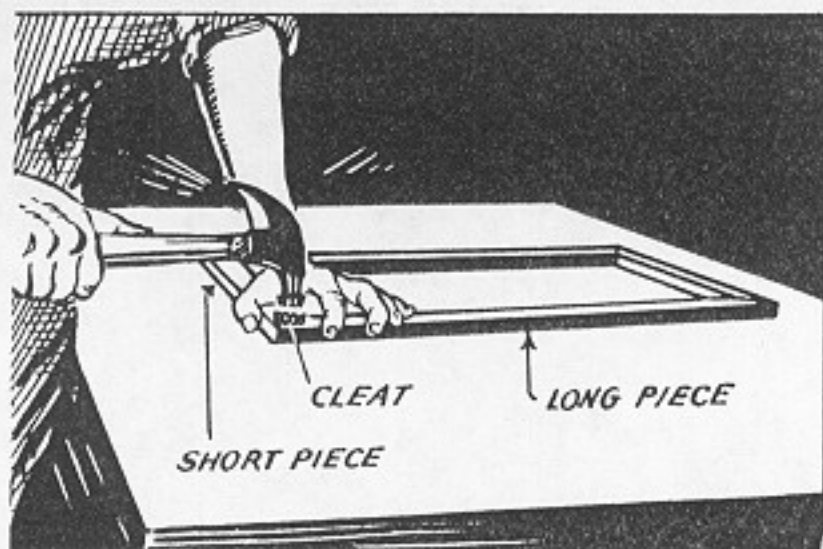


Fig. 25. Miter Joint Fastened With Cleats

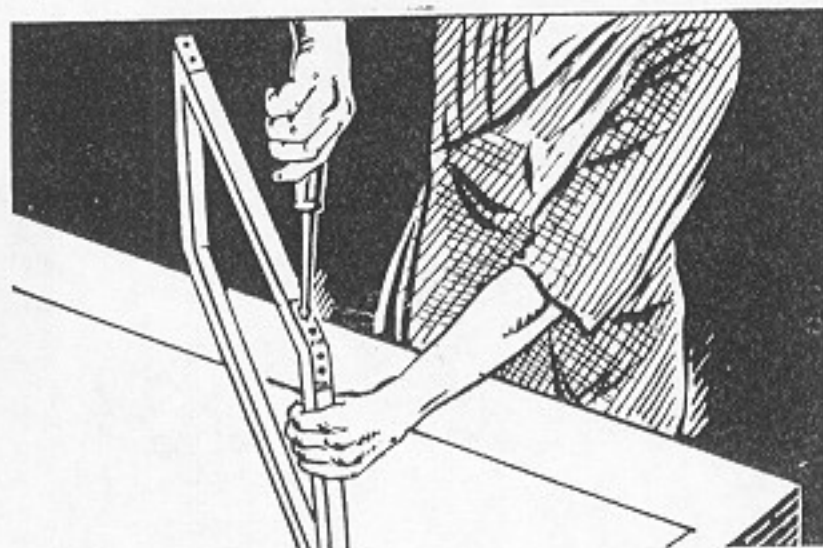


Fig. 26. Use of Angle Irons on Corners

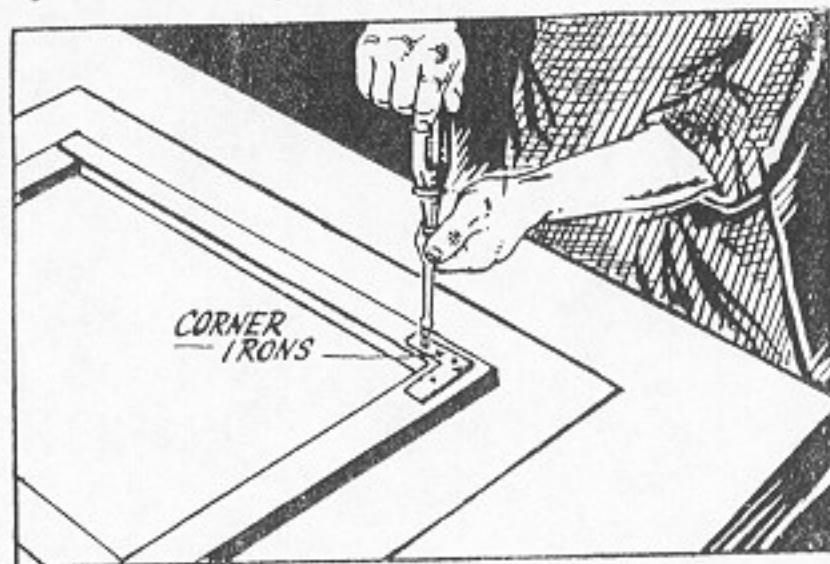


Fig. 27. Use of Corner Irons

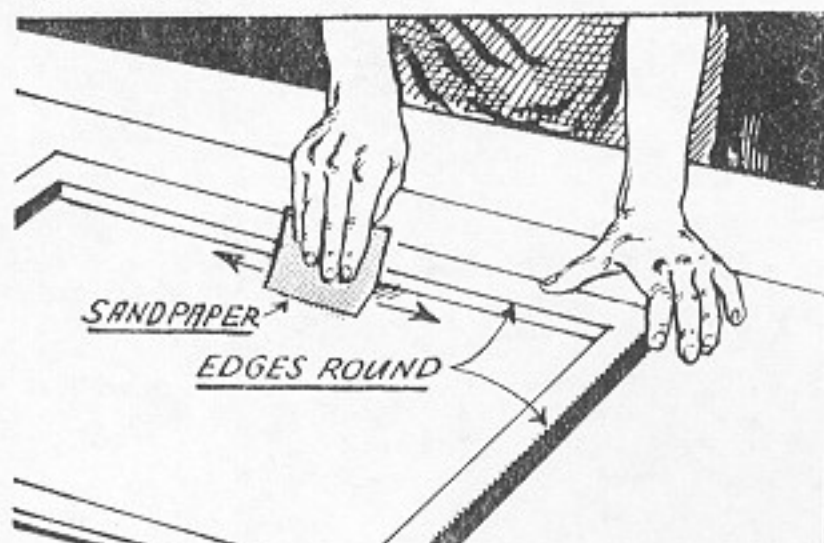


Fig. 28. Sand the Edges

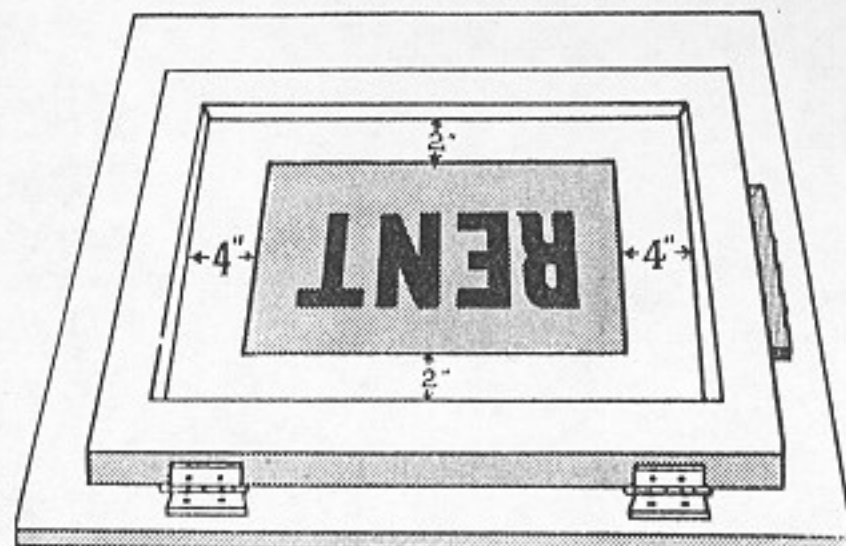


Fig. 29. Paint Reservoir Allowance

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which constitute the average areas allowed for the "paint reservoir." For best results in printing, the silk should be drum tight across the frame.

1. Fold a strip of silk lengthwise and tack it on the frame, as shown in Fig. 30. This strip acts as a cushion and prevents the stretched silk from tearing when it is tacked to the frame. There should be at least two thicknesses of silk in the pad. Tack such a strip on all four sides of the frame.

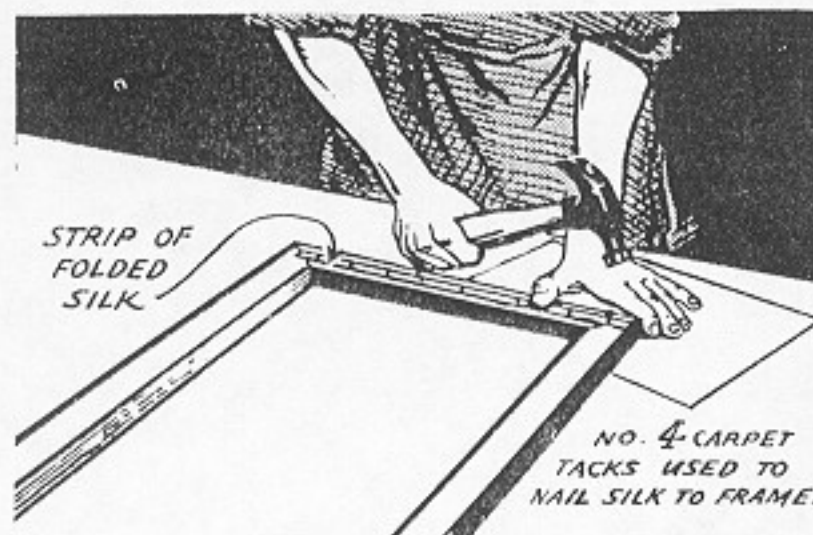


Fig. 30. Tack Silk to Frame

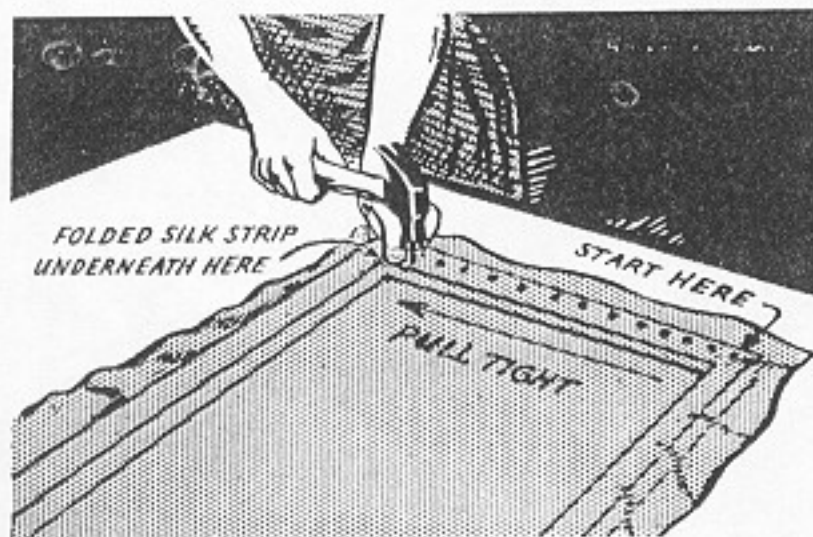


Fig. 31. Tack Silk to First End

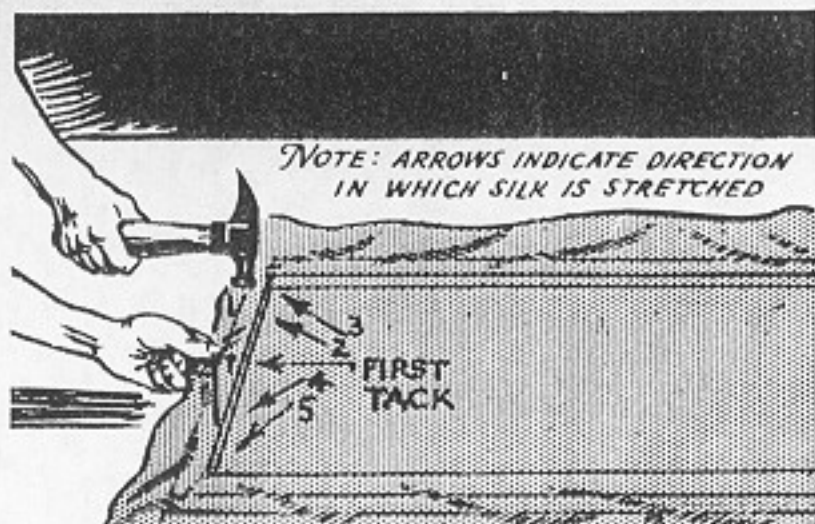


Fig. 32. Tack Silk at Opposite End

2. Tack the sheet of silk at one corner of the frame. Stretch the silk along one of the short sides and tack it, Fig. 31.
3. At the opposite end of the frame, pull the silk tight in the center. Tack the center, being sure that the weave of the silk is parallel to the sides of the frame. Pull and tack the silk as shown in Fig. 32.
4. Tack along one of the long sides of the frame, using the same procedure as in step 3. Place the first tack in the center of the side, then tack and stretch the silk to the ends, Fig. 33.
5. Tack along the edge in the same manner, Fig. 34. The silk should be stretched tightly on the frame and there should be no wrinkles. Trim the excess silk from the edges with a razor blade.
6. To further protect the tacked edges of the silk, the surface of the frame is taped, Fig. 35. Use the "glue solution" of one part glue and three parts water to moisten the gummed tape. Tape the edges of the frame as shown, overlapping $\frac{1}{4}$ of an inch to $\frac{1}{2}$ inch of the silk mesh.

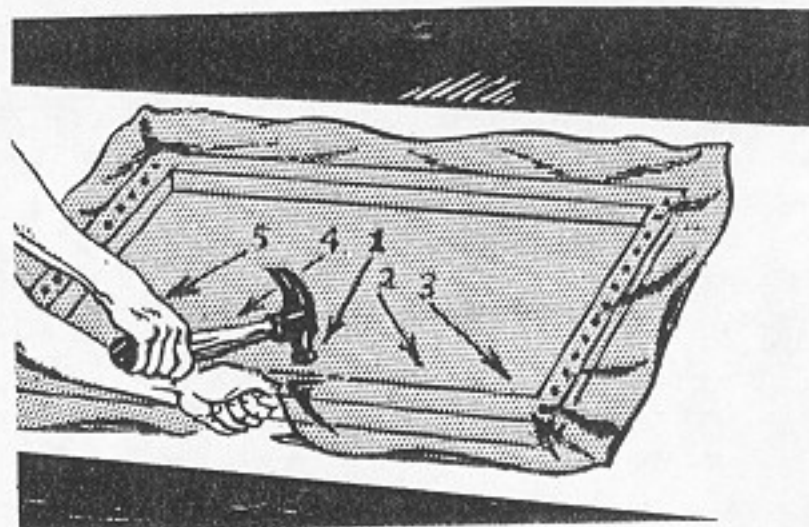


Fig. 33. Tack Silk Along One Side

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7. Turn the screen, basin side up. Fold the tape in half lengthwise and apply it to the inside of the frame, Fig. 36. One half of the strip should be on the frame and one-half on the stretched silk. Small pieces of gummed tape should be attached to the corners of the frame to prevent possible leakage through the joints.
8. Allow the taped parts of the screen to dry for several hours. Apply a coat of shellac to all of the taped areas inside and outside the screen. Let the shellac extend about one-fourth of an inch past the tape onto the silk screen, Fig. 37.

Attaching the Frame to the Base

The base is used as a support for the frame. Any flat wood surface which is larger than the frame will be satisfactory. Drawing boards are commonly used. In many cases the frame is attached directly to the table top.

Another important use of the base is to locate the sheets to be printed, so that successive colors will be applied in the proper positions. Strips of paper, cardboard, metal, celluloid or plastic may be fastened to the base with glue or tacks. These strips are called *register guides*. It is usually best to use three guides, although many times two are sufficient. The guides should not be thicker than the piece to be printed. Figs. 38 and 43 respectively show paper and cardboard guides in position.

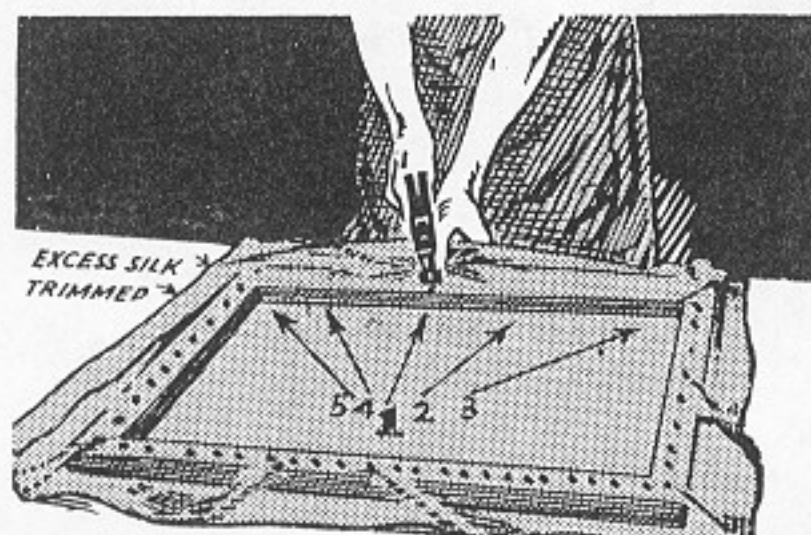


Fig. 34. Tack Silk Along Other Side

The frame must be hinged so that it can be lifted to remove a printed sheet and insert a fresh one. There are several ways in which this can be accomplished:

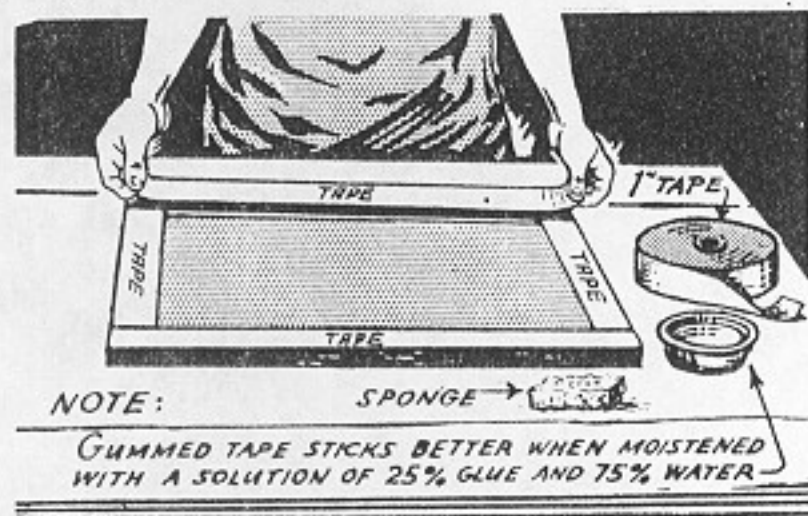


Fig. 35. Cover Edge of Silk With Gummed Tape

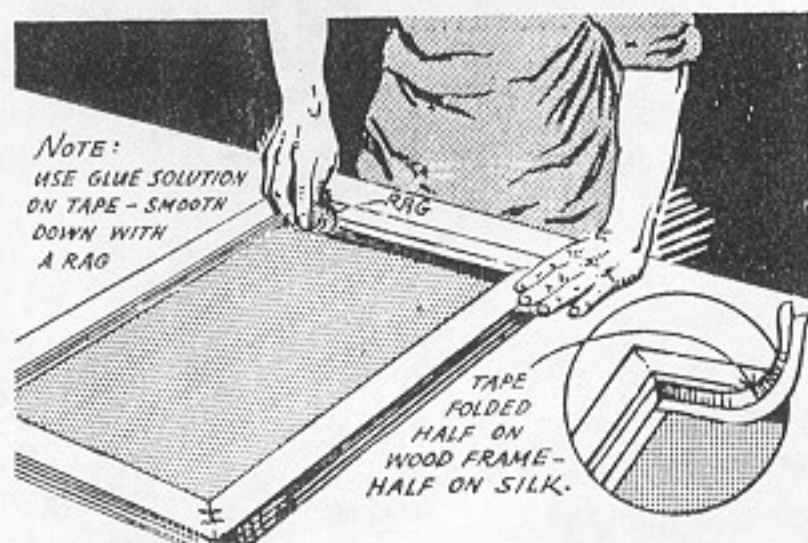


Fig. 36. Place Tape in Corners of the Frame

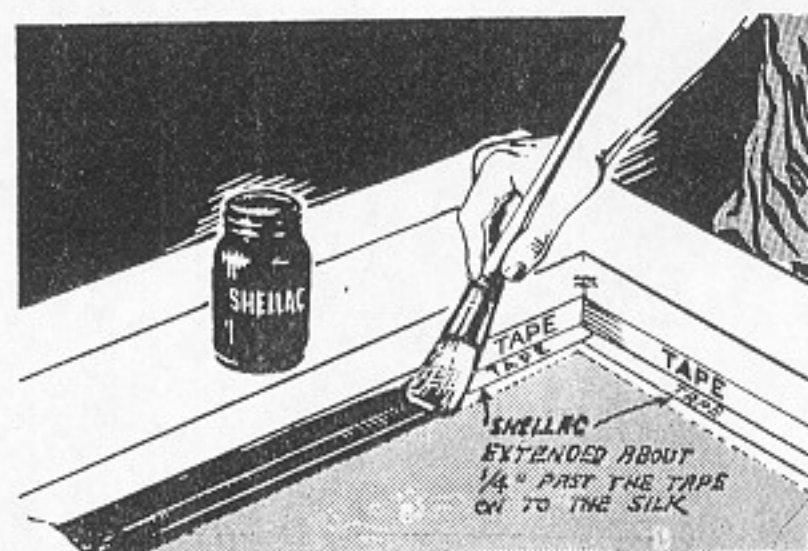


Fig. 37. Shellac Over the Tape, Covering About 1/4" of Silk

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1. The frame may be hinged directly to the base as in Fig. 39. Note that one set of hinges has the male part attached to the base while the other set has the female part in that position. This arrangement gives more stability to the hinging. Be sure to use loose-pin butt hinges so that the frame can be removed without removing the oval head screws.

2. The frame may be hinged to a back bar of the same height and approx-

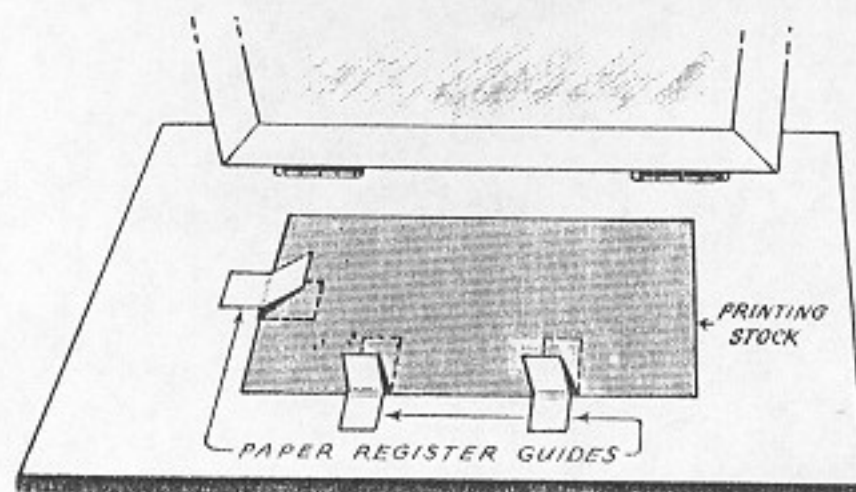


Fig. 38. Paper Register Guides

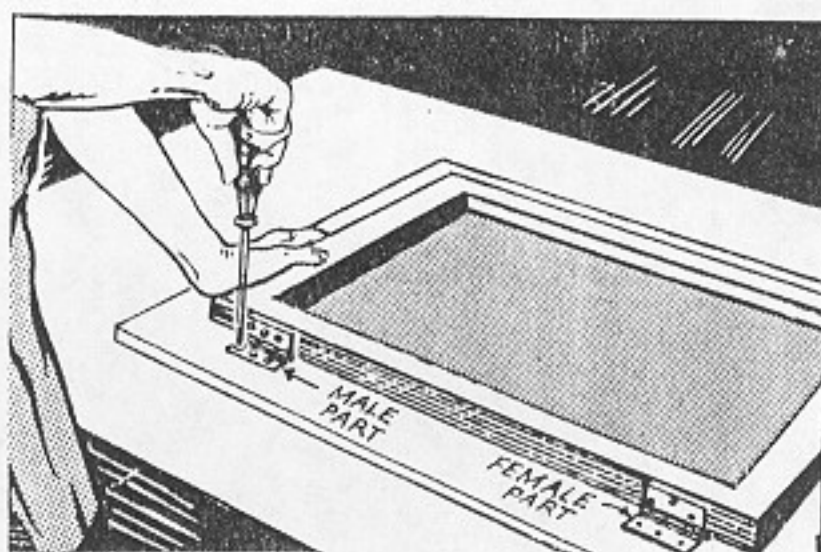


Fig. 39. Hinge Frame to Base

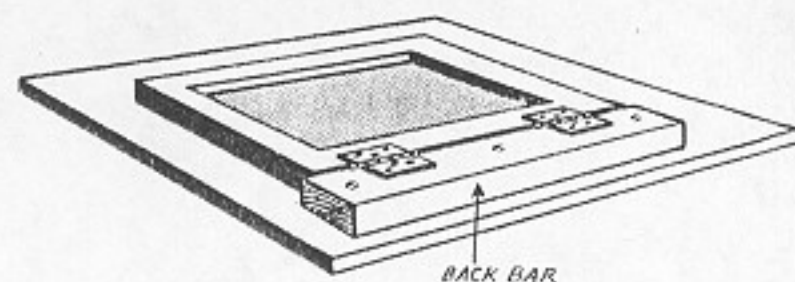


Fig. 40. Frame Hinged to Back Bar

imately the same length as the frame, Fig. 40. The back bar is attached to the base with screws or nails. Note that the hinges must be placed with the pin between the back bar and the frame, Fig. 40.

3. Fig. 41 shows a back bar which is attached to the base with wing nuts. A bar of this type may be raised or lowered so that it is exactly the same height as the frame. The height should be adjusted with a piece of the material to be printed inserted beneath the frame.

Supporting the Frame

The screen frame must be kept away from the printing surface while a fresh piece of printing stock is being inserted, and also while the guides are being placed in position. There are at least three simple methods of supporting the frame in a raised position.

1. The simplest and most common method is to attach a drop stick about 10" to 12" long to the side of the frame, Fig. 42. It should be attached in such a manner that it swings loosely and will drop into position when the frame is raised. Such a strip of wood is frequently called a *leg stand*.
2. When a long run is to be made, an arrangement such as shown in Fig. 43 may be practical. A supporting frame is attached to the edge of the table, the screen frame is hinged directly to the table and held up away from the printing surface by means of the doorspring attached at the right side. This type

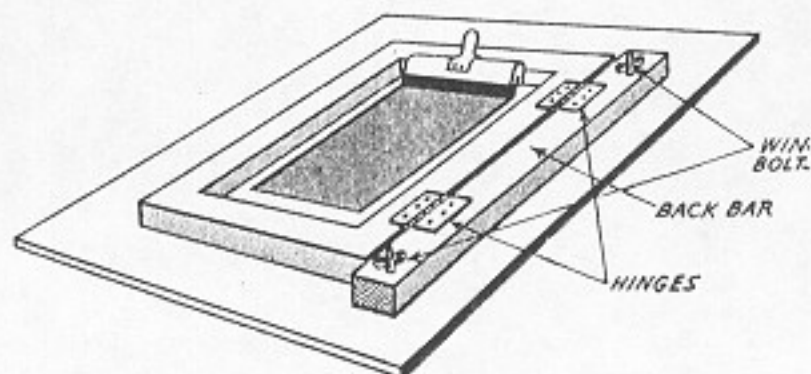


Fig. 41. Back Bar Fastened With Wing Nuts
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of installation requires that the printing frame be pulled down into position and held while the squeegee is pulled across the screen.

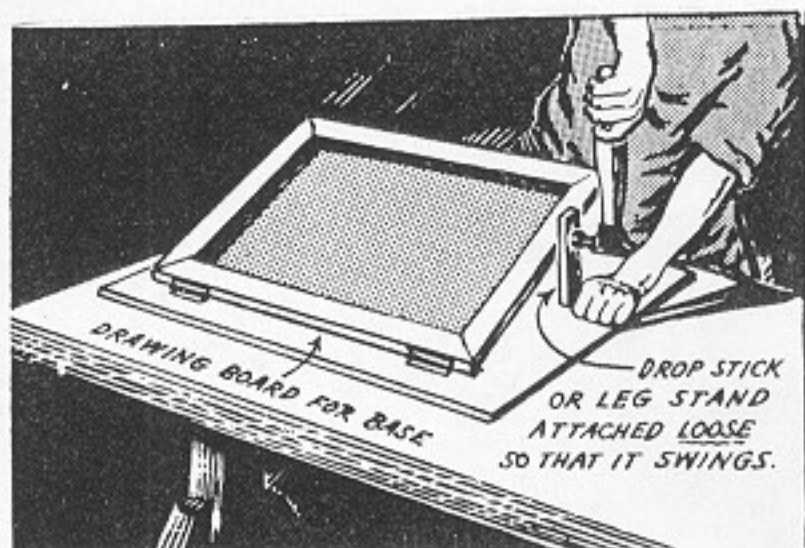


Fig. 42. Fastening Leg Stand in Place

3. Another method that is often used for long runs is illustrated in Fig. 44. The iron straps are attached to the ends of the frame and the weights placed in such a position that they hold the screen away from the base. The screen can be brought flat against the table by a slight pull from the operator.

Caution must be exercised in the use of the last two devices to keep the frame from being tilted to an angle which will permit the paint to run over the back edge of the frame.

Additional Hints

After the frame is completed and some experience in silk screen printing is gained, the individual operator may wish to add some extras to his equipment. Some of the most practical helps the author has seen are the following, which are illustrated in the complete screen set up, Fig. 45.

A *long nail or dowel pin* attached to each side of the squeegee enables the operator to rest the squeegee on *forked props* at the side of the frame. This prevents the squeegee housing from getting into the paint.

A *metal handle* attached to the front of the frame makes it much easier to raise and lower the frame and reduces the possibility of moving it to one side while raising it.

A *table top* of $\frac{3}{16}$ " wallboard or masonite is perfectly smooth and flat, making an ideal printing surface. The board may be nailed or glued to the table.

Other fabrics. Silk screen fabrics are now available in nylon, dacron and wire meshes of phosphor bronze, monel metal and stainless steel. They are more costly but all have

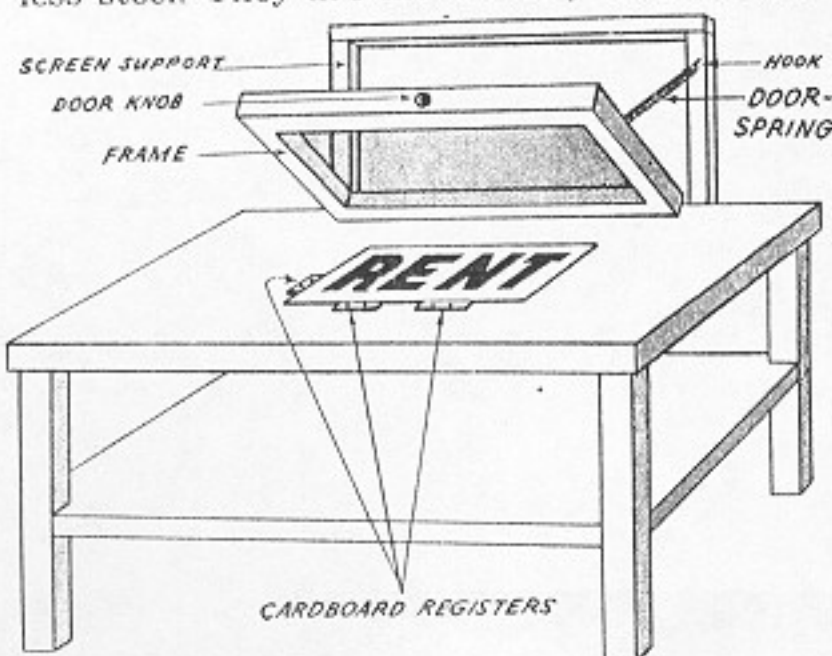


Fig. 43. Use of Door Spring for Frame Support

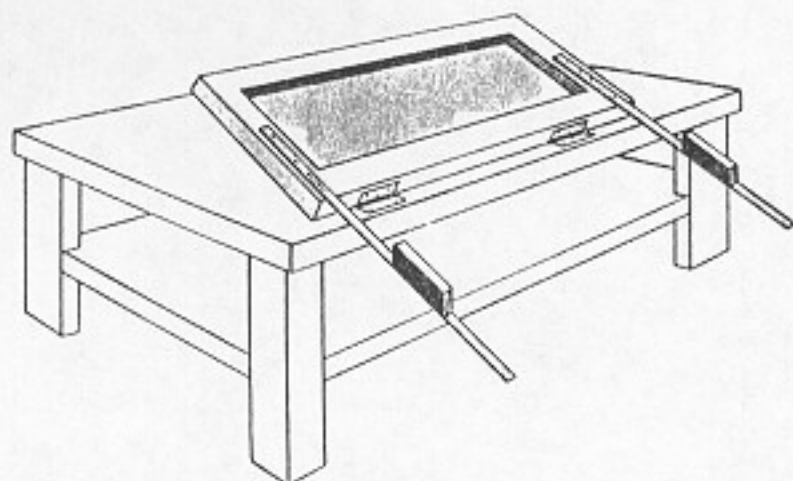
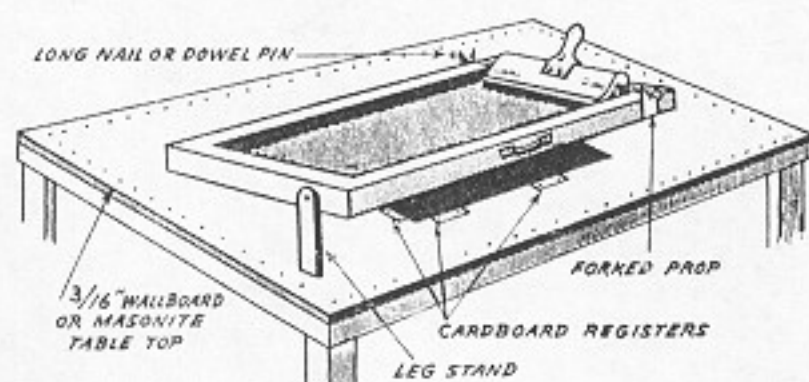


Fig. 44. Use of Counterweights to Support Frame

Fig. 45. Table Top Screen Unit With Squeegee Supports
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greater tensile strength than pure silk or cotton. Nylon is not generally recommended for hand cut stencils, but rather for direct photographic techniques (covered in a later chapter of this book). Dacron is highly recommended for any technique, and due to its immunity to atmospheric changes, it is excellently suited for multicolor printing in close register. It remains virtually unaffected by all solvents, including caustic soda. The wire meshes may be used with any type stencil and have greater tensile strength than nylon or dacron. A word of caution when using any of these materials: since none of them shrink, it is of even greater importance that they be stretched tightly on the frame. Normally silk or cotton will "take up" a little after being moistened.

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Chapter 4

Additional Equipment

The Squeegee

The squeegee is used to push the paint across the silk screen and through the open meshes onto the printing surface beneath. The squeegee consists of three parts; a rubber blade, a wood housing and a grip handle.

Squeegees may be purchased at graphic arts supply stores, or they may be made easily and with little expense.

Rubber Blade

The rubber blade is a strip of rubber belting about $2\frac{1}{2}$ inches wide and $\frac{3}{8}$ of an inch thick, Fig. 46. If a squeegee is being selected or made for a particular job, the blade should be about 2 inches longer than the width of the stenciled area of the screen. Conversely, it should be shorter than the width of the screen frame to allow for easy manipulation.

After it is used for some time, the rubber blade may become rounded from wear, Fig. 47. It should be kept square and sharp at the edges. A rounded blade may be sharpened by scraping it on a sandpaper block as shown in Fig. 48.

Wood Housing

The housing is a device for gripping the rubber blade securely and holding it so that it will not bend, Fig. 49. The housing may

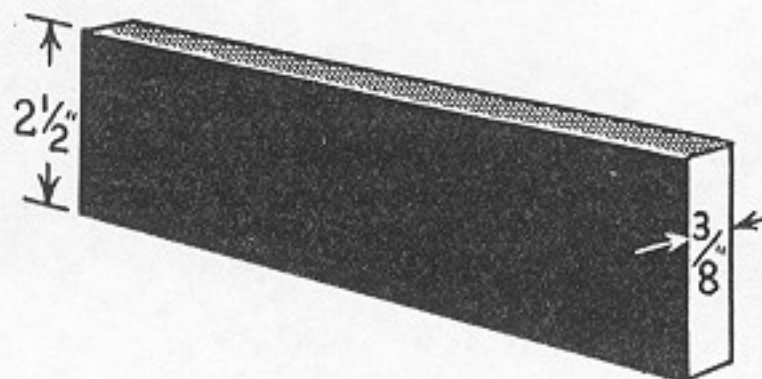


Fig. 46. Rubber Blade

be a single piece of wood as shown in Fig. 50, or it may be easier to sandwich the rubber blade between two flat pieces of wood. The housing should be recessed sufficiently

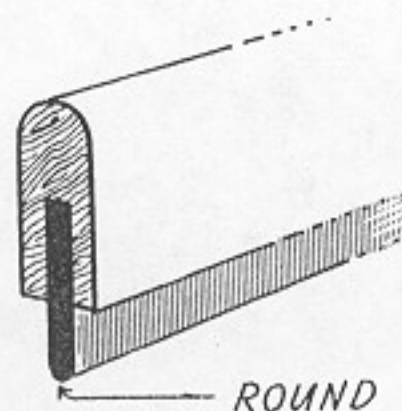


Fig. 47. Blade Rounded from Wear

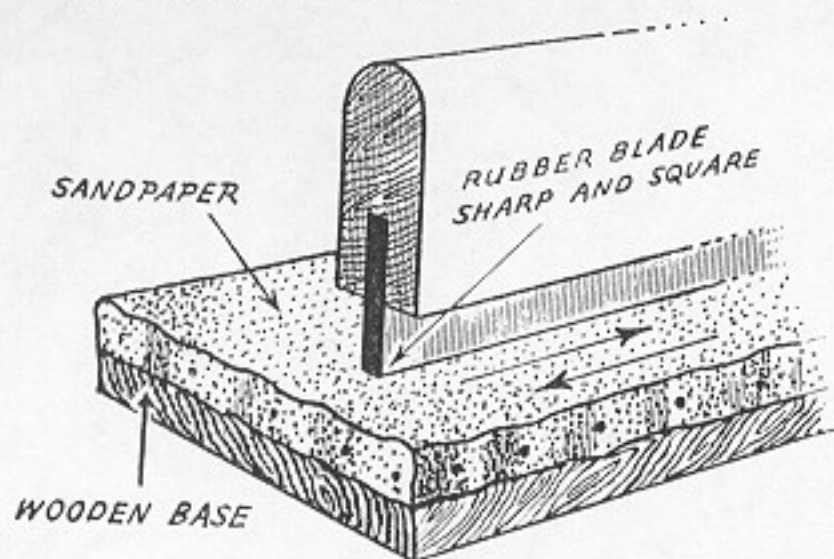


Fig. 48. Sharpening Squeegee

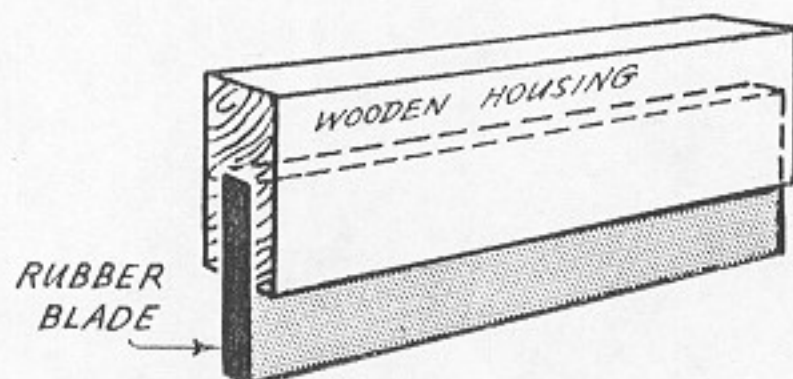


Fig. 49. Rubber Blade Inserted in Wood Housing

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deep to accommodate about one-half to three-fourths the width of the blade. The rubber blade may be held in place with glue plus flat head screws driven through the lower part of the housing (See Fig. 52). Care should be exercised in cutting the recess that it is not made so wide that the blade will not be held tightly.

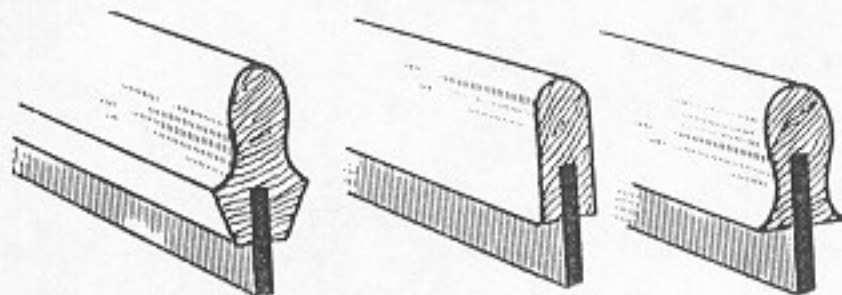


Fig. 50. Shapes of Wood Housings

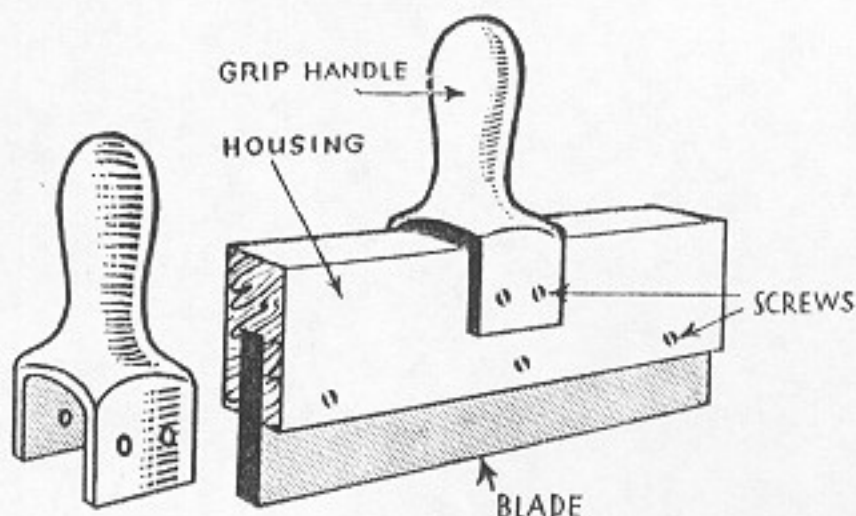


Fig. 51. Wood Handle

Fig. 52. Assembly of Squeegee

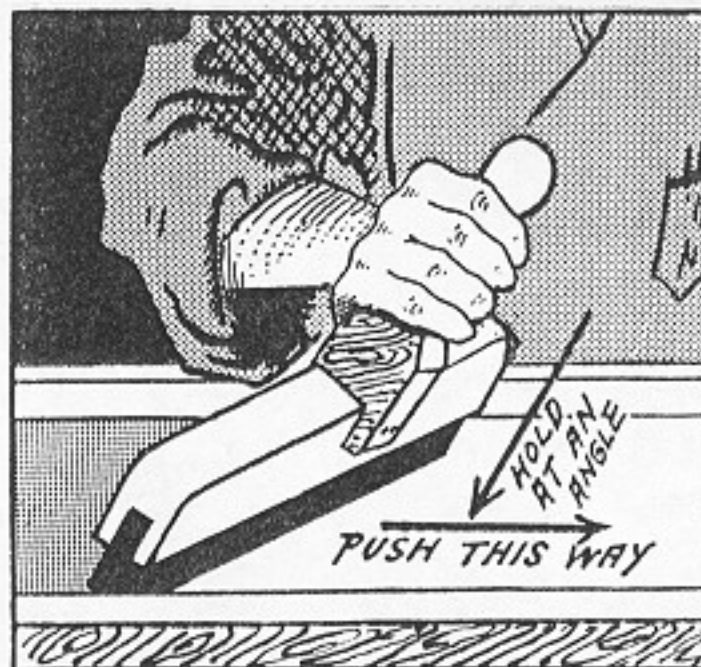


Fig. 53. Use of Squeegee

Grip Handle

Handles similar to that shown in Fig. 51 may be purchased at supply stores or a handle may be made of wood and joined to the housing. Fig. 52 shows the construction of a one-handed squeegee. In this instance the blade is held in place with screws. It is necessary to avoid tightening the screws so much that the housing is broken.

Using the Squeegee

The squeegee should be held at an angle with the screen and moved in the direction of inclination. Moving it while it is held at an angle forces the paint through the screen with the sharp edge of the rubber blade. If the blade becomes rounded it will take more pressure to force the paint through the mesh of the screen. Fig. 53 shows the correct

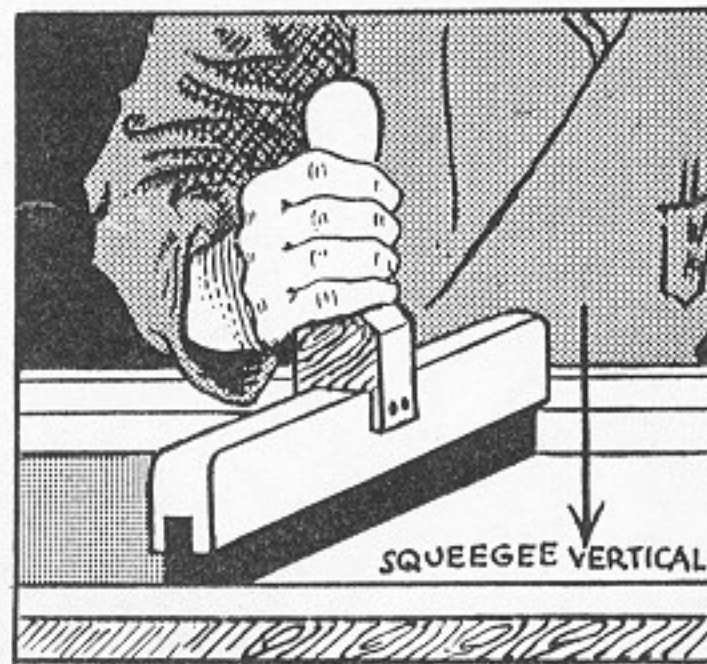


Fig. 54. Incorrect Use of Squeegee

use of a one-handed squeegee.

CAUTION: Never hold the squeegee in a vertical position as in Fig. 54. It is quite apt to smear the printed copy and is more likely to damage the stencil since heavier pressure must be used.

Where the length of the squeegee must be more than twenty inches, the two-handed squeegee is favored. It should be held as shown in Fig. 55 and drawn toward the operator. Remember to keep the squeegee inclined toward the direction of motion, so

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that the sharp edge of the blade will force the paint through the screen. Handles may be attached to a long squeegee as in Fig. 56. If the blade is more than thirty inches long, good results can be insured by having two persons manipulate the squeegee, one on each side of the frame. The two pull the squeegee across the screen slowly and in unison.

Most squeegee blades are available in soft, medium and hard rubber. Special blades are available for use with lacquer and vinyl plastic pigments. For printing on textiles, where too heavy a deposit of paint is usually not desirable, a special blade and handle are available, in which combination the blade does not protrude as far as it does for general printing. Blades are also available in synthetic rubber. Some textile printers prefer using a special squeegee made of birch or some other hardwood with a carefully finished and sanded edge.

Drying Racks

Silk screen paint requires a little time to dry thoroughly. The time required depends upon the surface of the material printed, the thickness of the paint layer, and the climatic conditions. Usually silk screen paint deposited rather lightly on paper or cardboard will dry in one-half hour; a heavy deposit on metal may require as much as twenty-four hours.

Wet sheets cannot be stacked one upon another without *offsetting*; that is, the paint comes off on the back of the sheets in the pile. For that reason, the individual prints must be kept from touching other prints while they dry. For short runs of fifty or so, the printed pieces may be placed on tables, chairs or even on the floor. Longer

runs require a more convenient place and one that does not require so much area.

One easy method for prints on paper or cardboard is to suspend them on a wire line with paper clips, Fig. 57. The wood rack shown in Fig. 58 can be combined with other similar racks to provide a flexible storage rack, one that can be adjusted to various sizes of prints. Such a wood rack can be easily made from pine strips about $\frac{1}{2}$ inch by 2 inches in cross section. Cross pieces may be about 30 inches long, with the

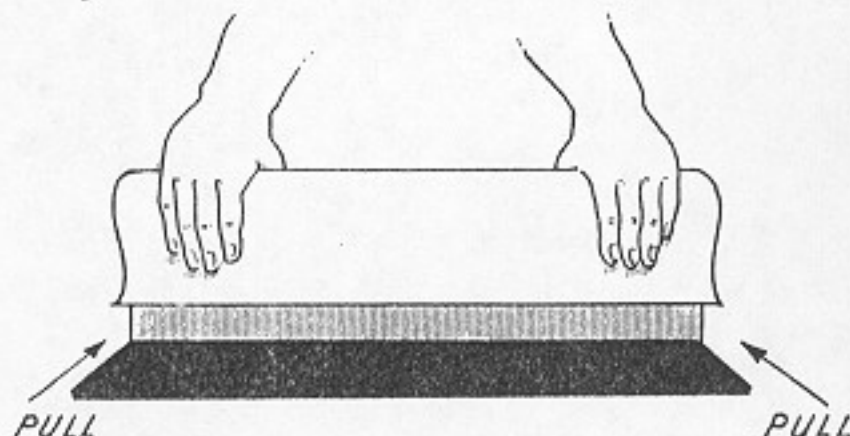


Fig. 55. Two-Handed Squeegee

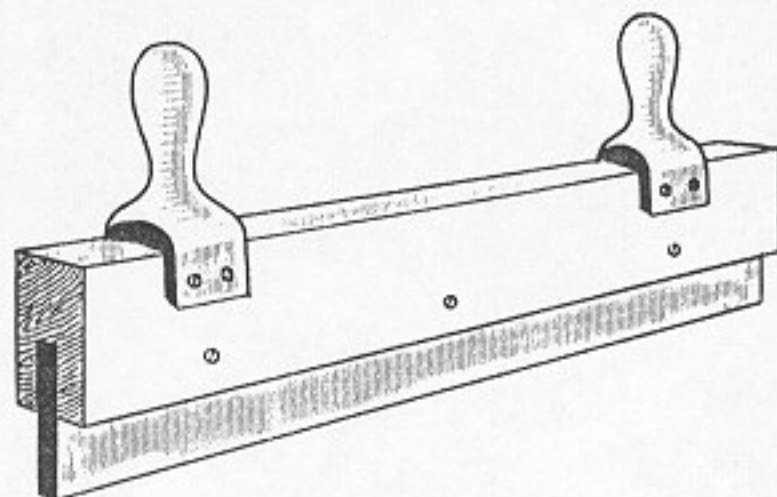


Fig. 56. Placement of Handles on Two-Handed Squeegee

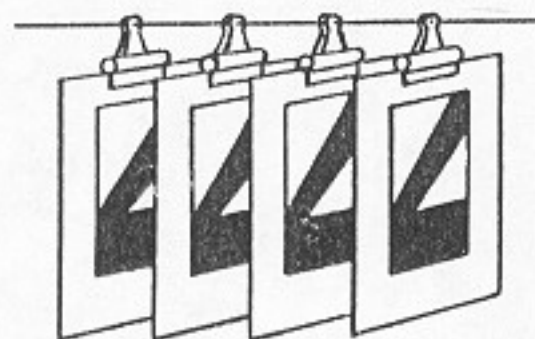


Fig. 57. Simple Drying Arrangement

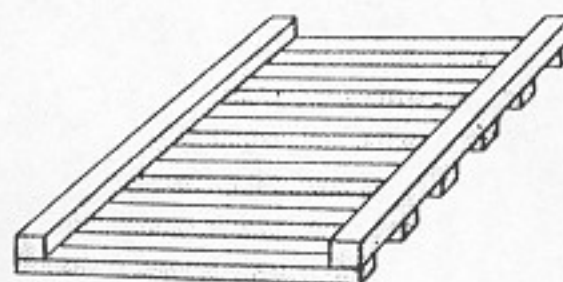


Fig. 58. Wood Drying Rack

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length of the rack any desired dimension. A rack 70 inches long is not uncommon.

Figs. 59, 60, 61, 62 show racks which are used in professional shops. The low rolling platforms are very practical, since the prints may be loaded on a truck as they are made, then moved to another location to dry.

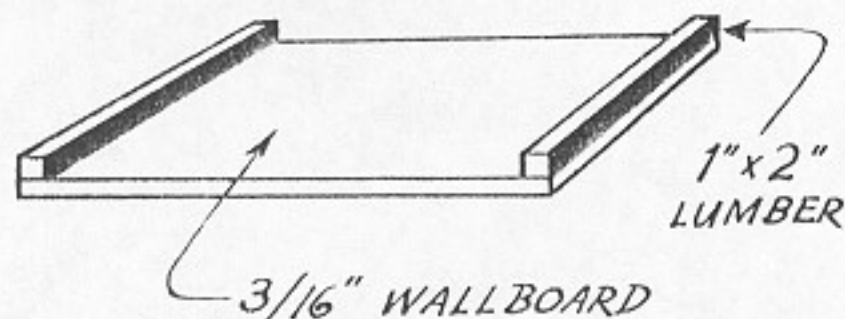


Fig. 59. Wallboard Rack

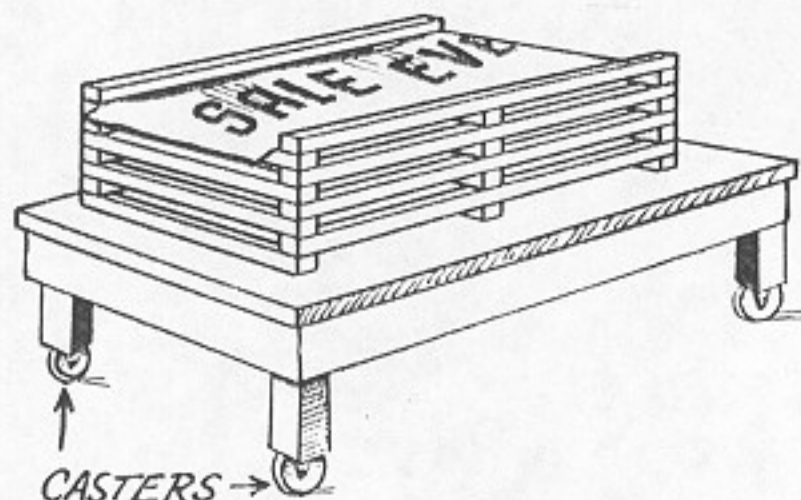


Fig. 60. Portable Rack and Truck

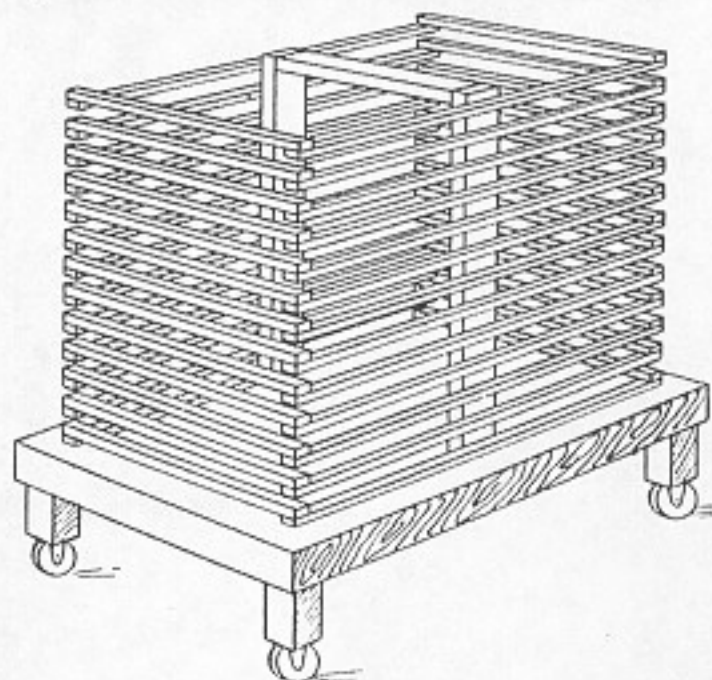


Fig. 61. Rack Permanently Attached to Truck

Infra-red heat may also be utilized to speed up the drying process. A single lamp fitted into a goose-neck desk fixture, Fig. 63, usually proves satisfactory for home or school use. Fig. 64 illustrates an industrial drying unit through which the printed pieces pass at drying temperatures.

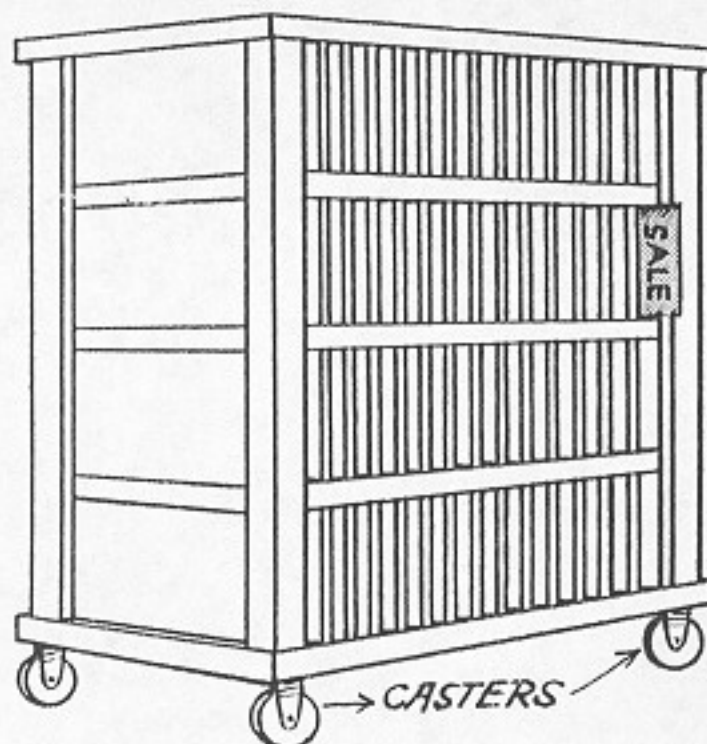


Fig. 62. Movable Rack in Which Cards Are Stored Vertically

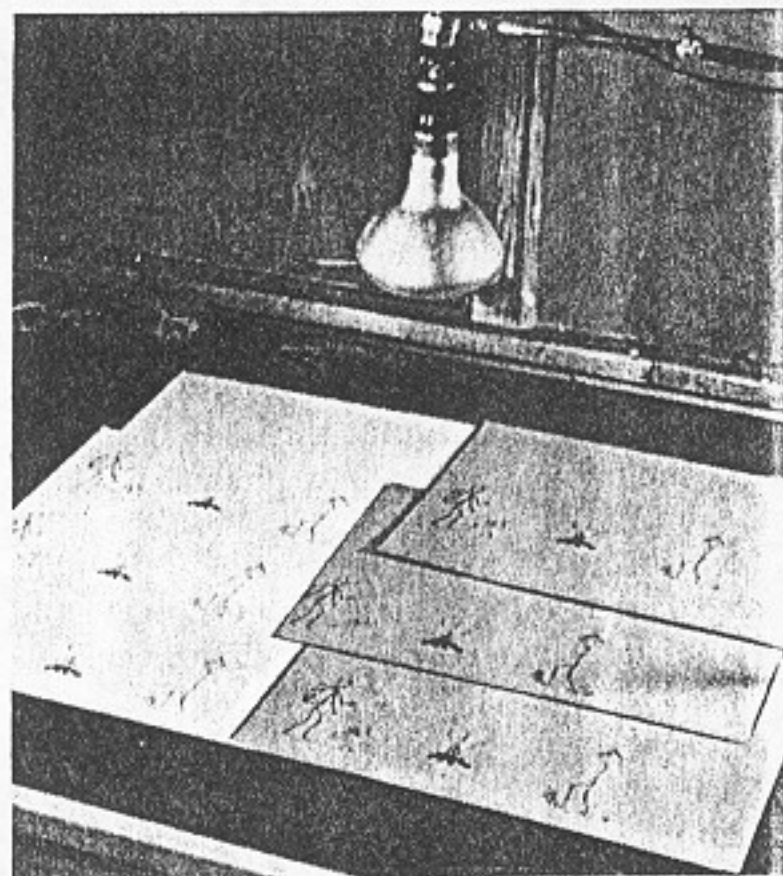


Fig. 63. Lamp Set-Up Suitable for Home Drying

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Special Jigs

It is sometimes necessary to print on a surface which is higher than the thickness of the paper or card stock, such as on a wooden toy or the side of a box. To do this, the backbar, illustrated in Fig. 41, is raised to the same height as the object to be printed, by using various thicknesses of wood and cardboard strips in combination. The bolts on which the wing nuts are fastened will have to be replaced by longer ones to accommodate the greater height.

A jig is then constructed from wood and

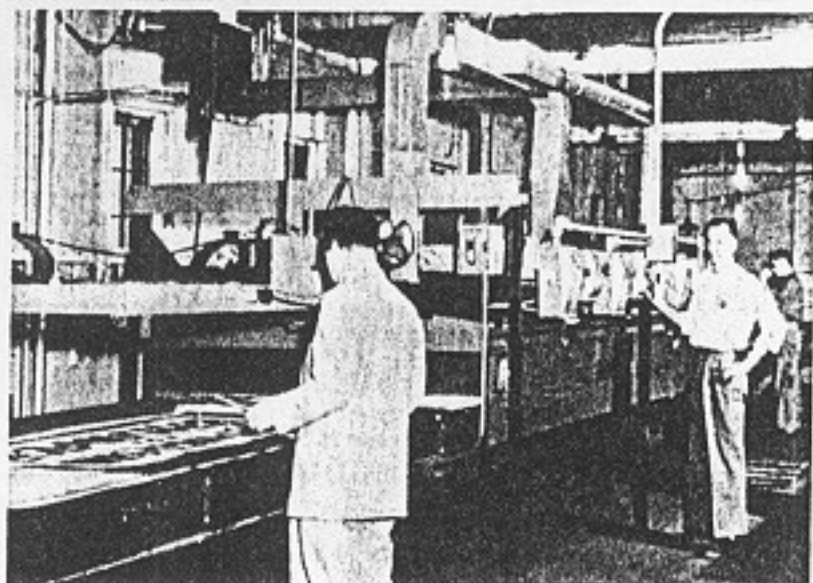


Fig. 64. An Industrial Drying Unit
Courtesy, Fosterite Pressed Steel Corp.

cardboard strips and fastened to the baseboard in such a way that the object to be printed can be placed into it, Fig. 65. If the jig does not extend, on the baseboard, beyond the three *unhinged* sides of the frame, so that it will support the frame, then additional build-ups of wood and cardboard should be fastened to the baseboard so that the edges of the frame rest upon them.

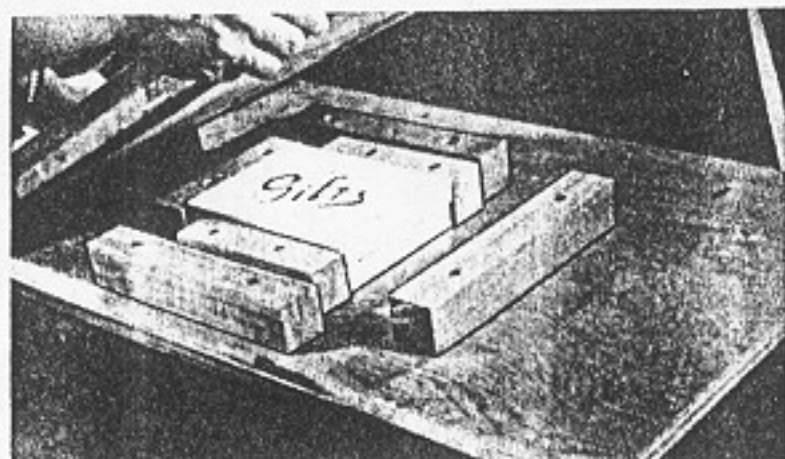


Fig. 65. Built-Up Jig for Printing a Box
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Chapter 5

Colors and Color Mixing

Silk screen oil process paints, enamels and lacquers are each especially ground and mixed for the various types of silk screen work. They are sold under trade names by sign and graphic arts supply stores and usually by arts and crafts shops. These colors have the right brilliance and covering capacity and do not require extensive mixing. The colors are available for either indoor use or for outdoor exposure.

Silk screen colors are usually in paste form. Before they can be used, they must be thinned to the proper consistency. The paint should be thinned until it is about the consistency of molasses. Stir well and break up all lumps. If the lumps remain in spite of continued mixing, the mixture should be strained through cheesecloth to remove them. The materials necessary to mix a batch of oil process color properly are:

Color. For most silk screen needs this usually has an oil base, and when purchased is in a paste form. It has been ground to a fine consistency and is combined with a quick drying medium.

Solvent thinner or reducer. This is usually a form of mineral spirit and is used to thin the paint to proper consistency. In an emergency it is permissible to use gasoline, turpentine or kerosene. For general use, though, gasoline and turpentine evaporate too quickly. Gasoline is also dangerous to use while turpentine is expensive.

For thinning silk screen colors, it is generally best to use the thinner or reducer recommended by the manufacturer of the color being used.

Mixing or retarder varnish. This is added to reduce the paint consistency, slow up

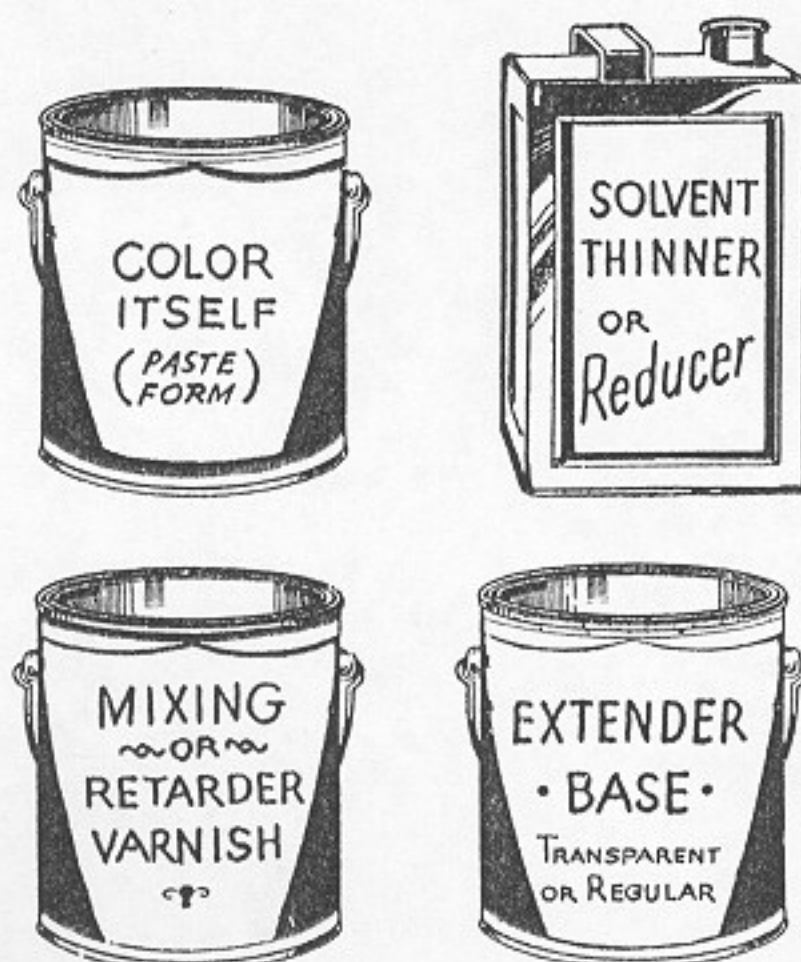


Fig. 66. Materials for Mixing a Batch of Oil Paint

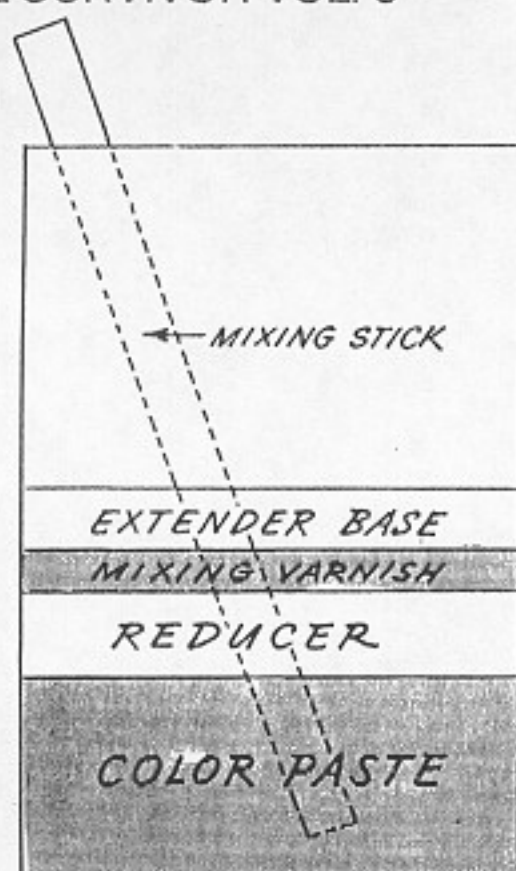


Fig. 67. Ingredients of Oil Process Color

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the drying, bind the color and prevent the paint from clogging the screen, Fig. 66. About one tablespoon to one pint of color is sufficient.

Extender base. This is added to increase the volume of the color, Fig. 66. There are two types of extender: regular and transparent. The regular extender looks and feels like putty and does not change the value of the color. It is used for economy, usually about 20% by volume being added. The transparent extender resembles vaseline in color and consistency. It is used when one color is to be overprinted, resulting in a third color. It reduces the opacity of paint and allows the color beneath to show through. For example, a transparent yellow printed over red will give orange. When using transparent colors, the darker color is printed first.

Mixing the Colors

Fig. 67 shows the general proportions by volume of ingredients used.

1. Remove some of the paste from the can with a clean mixing stick and place it in a clean container. Since excess paint can be saved and used on another job, be sure to get a sufficient amount.
2. Add the proper reducer or solvent. About half as much reducer as paste is about the right proportion.
3. Stir the reducer and the paste until they are well mixed. The consistency should be about like molasses — if too thick add more reducer. If too thin add more color paste and stir.
4. Add the mixing or retarder varnish, using the proportion of one tablespoonful of varnish to one pint of color. In an emergency, linseed oil may be used, or a mixture of linseed oil and kerosene.
5. Last, add the extender base, either regular or transparent, depending on the type of job. About 20% by volume is usually used.

Identification of Colors

A great deal of confusion exists concerning colors and color mixing, and there are times when the craftsman has a feeling that any color can be given almost *any* identification.

The important thing for the craftsman to keep in mind in all explorations into the study of color is that there are *three* primary (or basic) colors. Where these are obtained, how they are made, or why they are that color are studies for advanced research workers. These *primary* colors are red, yellow and blue. By mixing *equal* parts of any *two* of these colors, the *secondary* colors are produced. Thus, by mixing equal parts of red and yellow, *orange* is produced. *Equal* parts of yellow and blue produce *green*. *Equal* parts of red and blue produce *violet*. Therefore, orange, green and violet are the *secondary* colors. For the beginner, it is best to always call a *red* a *red*, an *orange* an *orange*, etc., regardless of whether it is lighter or darker than others which can be found. This holds true for all of the *primary* and *secondary* colors: red, orange, yellow, green, blue and violet. Fig. 68 represents these colors in chart form. To use the chart run the finger across the top line until the first color being used is reached. Then run the finger down the column until it is opposite the color on the left representing the second color being mixed. The box in which the finger rests will be the color resulting when *equal* parts of each are mixed together.

A *tint* of a color is produced by adding pure white to any one of the six colors mentioned. Thus, white added to red will produce *pink*, a color which most will recognize. A scientist will tell you that the *value* has been increased by the addition of white. In other words, more light is reflected back to the eyes thus creating an appearance of brightness. A *shade* of a color is produced by adding absolute black to any one of the colors. Thus, black added to blue will result in *navy blue*, a color most should be able to recog-

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nize. Here again a scientist will explain that the value has been decreased by adding black; less light is reflected from the color back to the eyes and the color gives the impression of being darker.

The chart in Fig. 68 also includes white and black. However, in these columns some colors are given names which may be otherwise indicated by other authors. It is assumed that the names given to these colors will be generally recognized. All other com-

binations have been omitted.

The *tertiary* (or third order) colors are produced by mixing equal parts of any *two secondary* colors. It is readily seen that this is the same as mixing *unequal* parts of any two primary colors. Thus, if green and

orange are mixed in equal parts the resulting color will be brown. Since green contains equal parts of blue and yellow, the orange contains equal parts of yellow and red, then brown actually contains *unequal* parts of the primary colors of red, yellow and blue. The addition of white to any one of these colors will produce tints of that color, and the addition of black will produce shades of that color. Hence, it is easily seen that almost unlimited ranges of colors are possible to the craftsman using a supply of red, yellow, blue, white and black.

Only brown has been listed in the chart because all other combinations seem to produce colors which the craftsman is better off identifying for himself.

	RED	ORANGE	YELLOW	GREEN	BLUE	VIOLET	BLACK	WHITE
RED	RED		ORANGE		VIOLET			PINK
ORANGE		ORANGE		BROWN				
YELLOW	ORANGE		YELLOW		GREEN		OLIVE DRAB	
GREEN		BROWN		GREEN				
BLUE	VIOLET		GREEN		BLUE		NAVY BLUE	PALE BLUE
VIOLET						VIOLET		
BLACK			OLIVE DRAB		NAVY BLUE		BLACK	GREY
WHITE					PALE BLUE		GREY	WHITE

Fig. 68. Color Chart

Other Pigments

Commercial water soluble textile paints. Several manufacturers have placed these on the market. They are thinned with water and the equipment may be washed clean with water. However, when the paints have dried and they are heat set, they are fully washable.

Non-heat-setting textile paint. A big boon to the home craftsman, this textile pigment is thermo-setting in air under ordinary drying conditions and requires no special heat-setting or curing.

Sizing and priming pigments. These are available for priming galvanized steel and other metals prior to screening with enamels for outdoor use.

Metallic pigments. Gold, silver, aluminum and other metallic pigments are available for mixing with clear extenders to produce metallic colors.

Da-glo. These popular colors, which have such a high reflective quality that they appear to glow in ordinary daylight, are now available to the home and school craftsman. They are not to be confused with . . .

Phosphorescent pigments. These are chemical mixtures, reputedly safe and non-toxic, which actually glow in the dark after absorbing light.

Adhesives. Adhesives of all kinds are available for use in flocking (the application of a powdered felt finish), in making decalcomanias (transfer and slide-off designs on paper), etc.

Vinyl plastic. These pigments are especially designed for application to sheet plastic such as used for shower curtains, table cloths, raincoats, aprons, etc.

Water tempera. Several commercial extenders are available which can be added to ordinary water tempera paints to give them the body and consistency needed for screening. This is especially valuable in schools where tempera used for various other techniques can be mixed to order for screening jobs. These colors are not waterproof or washproof but are recommended for posters, greeting cards and the like.

Powdered tempera. Under the trade name of Alphacolor, finely-ground, powdered tempera is available which can be mixed with a whole series of various vehicles and extend-

ers to satisfy almost every need. The dry tempera is mixed with *Textile Liquid* for screening on textiles. For an all-purpose screening paint the dry tempera is added to a special extender called *Craftmix*, Fig. 69. This mixture has the decided advantage of being soluble in water and absolutely not clogging the screen while operating. Many water soluble mixtures do clog quite rapidly because of the glue or egg albumin content. *Craftmix* is non-toxic and will not dry in storage. It is also odorless. It can be heat-set for permanency for colorfast printing on textiles.

Finger paint. Most good quality finger paints may be screened without the addition



Fig. 69. Dry Pigments, Liquid, and Extender
Courtesy, Weber-Costello Co.



Fig. 70. Finger Paints Are Suitable for Screening
Courtesy, Milton Bradley Co.

of special extenders³⁴ because their consistency is correct, Fig. 70. These are all water soluble.

Other water soluble paints. Many good brands of ready-mixed, water soluble screen paints are available to the craftsman. They are specially ground and mixed for screening and require just water for additional thinning. *Aqua-Process* silk screen colors, discussed in connection with direct photographic screening in Chapter 11 is one such

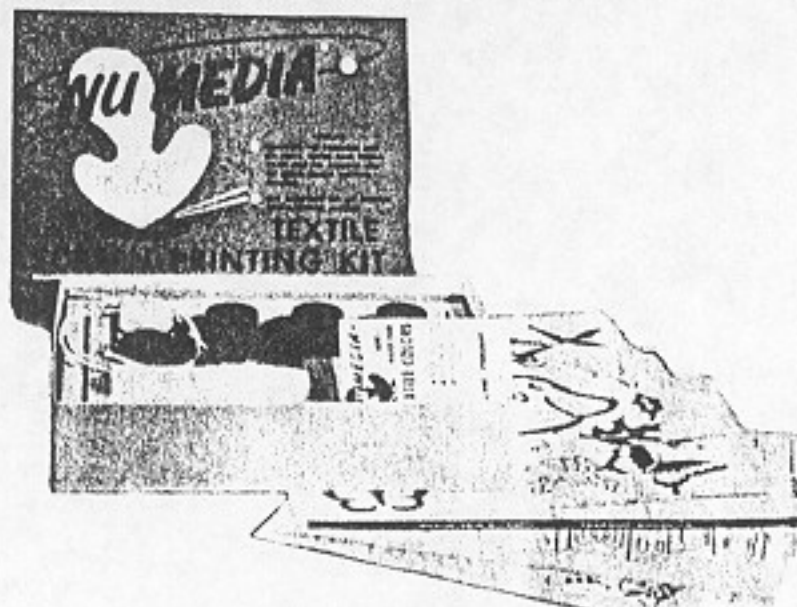


Fig. 70A. A Textile Printing Kit
Courtesy, Nu-Media

product. Nu-Media, which produces an all-purpose dry powder paint, also manufactures a water base, ready-mixed textile paint. Hands and equipment can be cleaned with water yet the paint becomes washfast and colorfast when heat-set in the usual manner. This product is available in small jars for home or school use and is also available in complete kit form, Fig. 70a. The kit contains a small, ready-made screen frame, stretching fabric, squeegee, design ideas and a full set of the ready-mixed colors.

It is difficult to underestimate the value of water soluble paints and pigments to the home craftsman and for school use, especially when they can be used for work requiring color fastness in laundering and dry cleaning. Water is used for thinning, water is used for cleaning *all* equipment, and water is used for cleaning the hands and accidental smudges. They are also virtually odorless and all are non-combustible.

A few moments spent looking through the pages of a screen processing supply catalog or a general arts and crafts catalog will assure the craftsman that pigments for any and all purposes are available.

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Chapter 6

The Paper Stencil Method

The paper stencil is one of the most simple of all silk screen methods. A paper mask is fastened to the silk screen and those areas which are to print are trace-cut. The paint or color is forced through these areas by the

squeegee, while the rest of the paper acts as a block-out medium.

The paper stencil is best for work involving simple designs or lettering on large areas. Store circulars, card signs (in quantities up to 200), real estate signs, display panels, outdoor posters (up to 24 sheet size), streamers, flags, banners and pennants are some of the most popular uses of the paper stencil method. The paper used for the stencils is not expensive and the stencils are easy to prepare. Fig. 71 shows various samples of poster work which are adaptable to the paper stencil method.

Materials and Tools

Besides the regular screen unit and paint, the following will be needed:

Bond paper. This should be a thin, transparent grade, so that the design may be viewed through it without difficulty. Tympan paper used by printers is excellent for stencils. The paper used to back a duplicating machine stencil is a variety of this tympan paper. There is also a commercial product available, made specifically for this purpose. It is a heavy, tough paper, thoroughly waxed with a hard wax, and transparent.



MARCH of Events

Fig. 71. Samples of Paper Stencil Screen Printing
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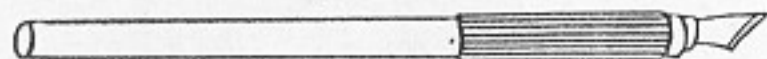


Fig. 72. Stencil Knife

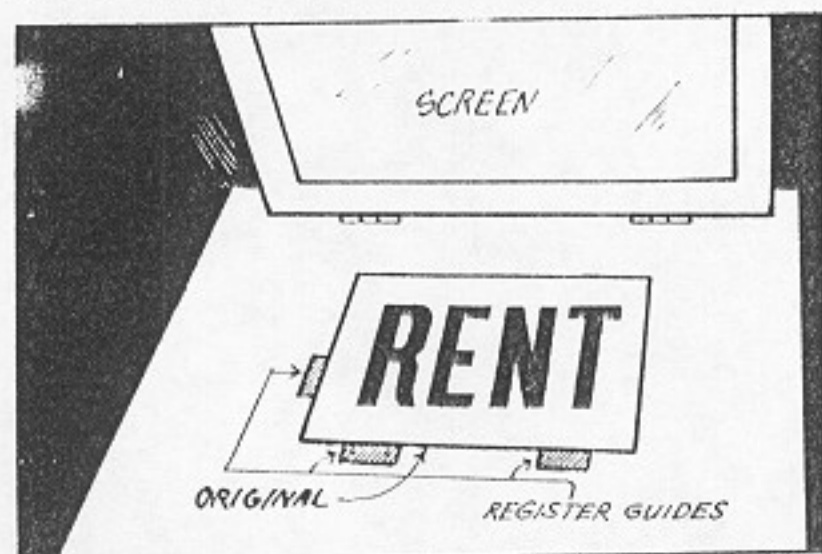


Fig. 73. Original Registered on Printing Surface

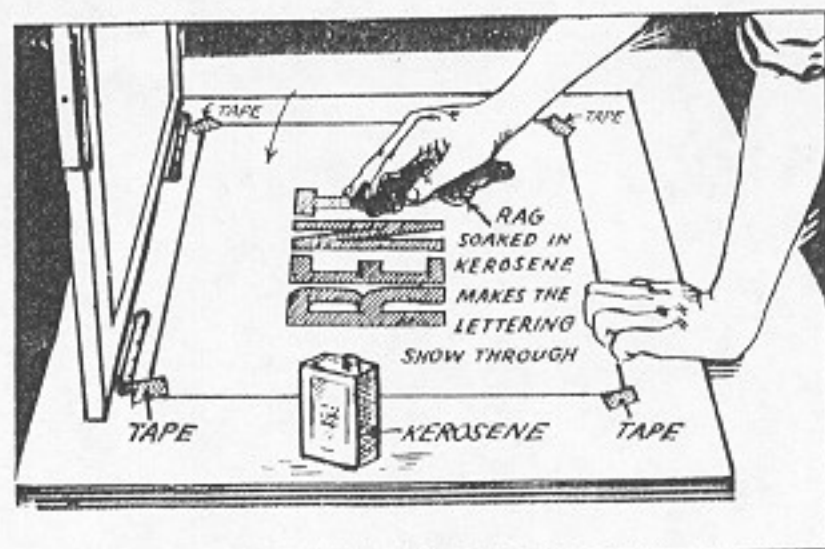


Fig. 74. Kerosene-Moistened Paper Is Translucent

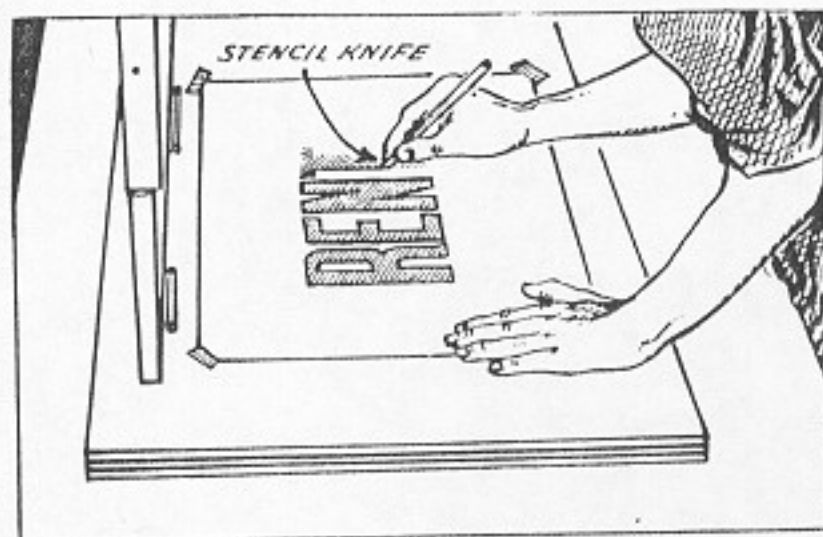


Fig. 75. Cutting the Stencil

Stencil knife. This will be used to trace-cut the lettering or design on the bond paper, Fig. 72.

Cellophane or masking tape. These are adhesive tapes requiring no moistening. Tape will be used to fasten the stencil paper over the original and also to the screen.

Kerosene. This will be used to clean the screen when the printing is finished. It is inexpensive, easy to obtain, and does a good job.

Cloth. This will be soaked in the kerosene and used to clean the screen.

Procedure

1. Place the copy to be reproduced directly under the screen, Fig. 73. Register it as shown.
2. Cover the original with bond or kraft paper and tape it at the corners to hold it securely in place, Fig. 74. Wipe the surface of the paper with a cloth soaked in kerosene. This makes the paper translucent, so you can see the original through the paper.

NOTE: When the commercial waxed paper is used, this last process is not required.

3. Trace-cut the lettering with the stencil knife. Follow the edge of the lettering or design carefully, for any mistakes will be reproduced, Fig. 75. Allow the letters to remain in place after the paper is cut through.

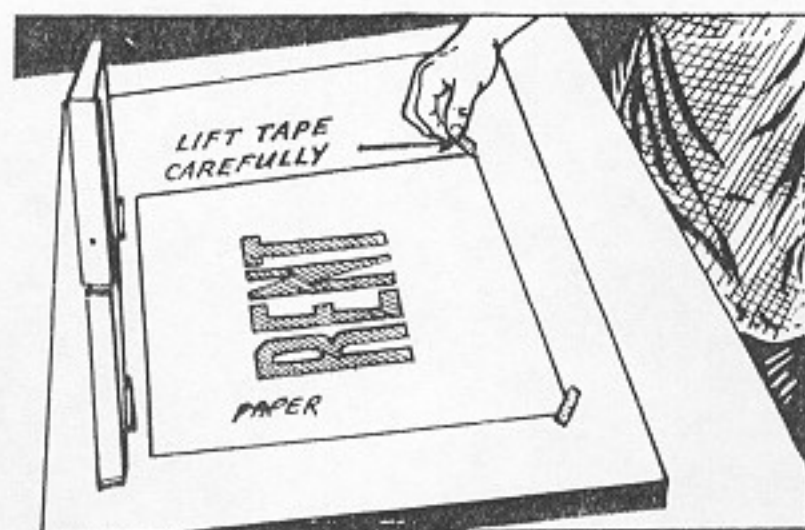


Fig. 76. Remove Tape, But Do Not Move the Paper

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4. Lift the tape from the corners of the paper. Be sure that the paper does not move out of register with the original copy, Fig. 76.
5. Lower the screen frame, add heavy paint and pass the squeegee across the screen. The paint acts as the adhering agent for the paper stencil, Fig. 77.
6. Carefully lift out the letters, or the parts of the design that are to print, Fig. 78.
7. Place a blank card in proper position for printing, Fig. 79. Lower the screen and force the color through the screen by passing the squeegee over the surface.
8. Raise the screen, remove the printed card, and insert another blank in register, Fig. 80. Print rapidly so that the screen mesh will not become clogged with paint.

Additional Hints

1. As compared to other types of stencils, the paper stencil is limited to the relatively short life of the paper itself. This is especially true if a water base paint

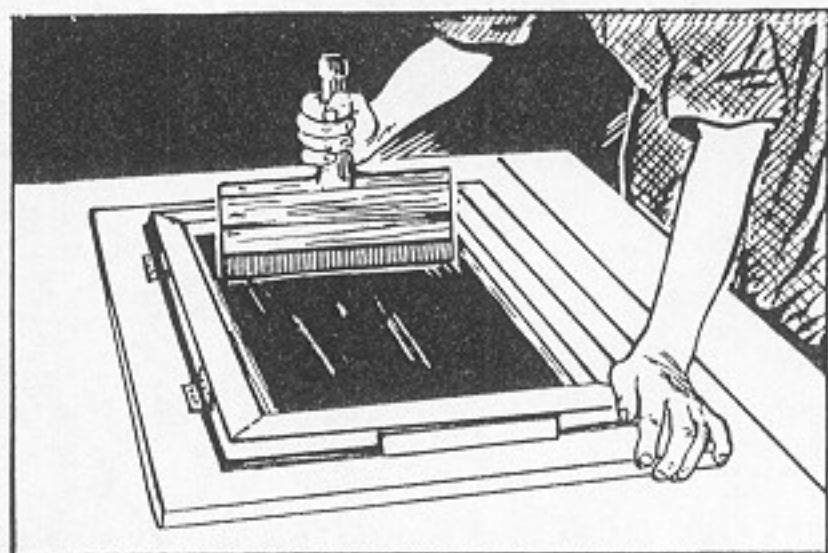


Fig. 77. Adhere Paper to Screen With Heavy Paint

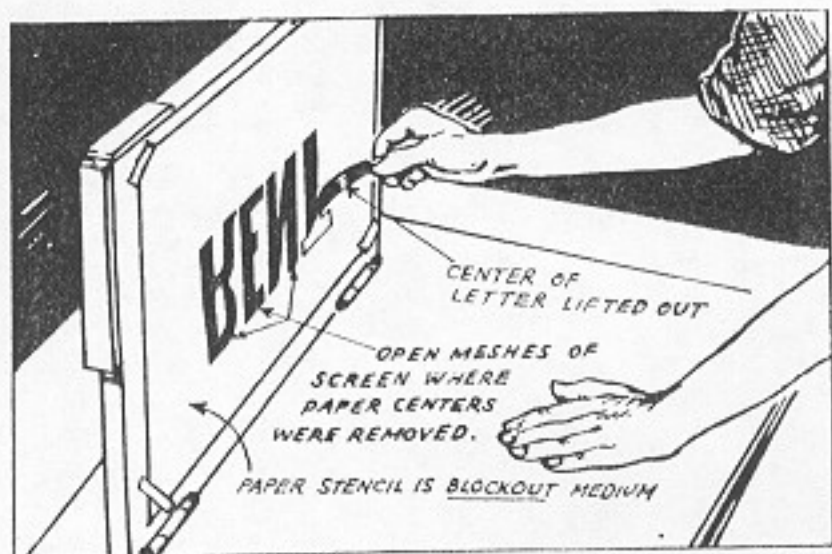


Fig. 78. Remove Printing Portions

is used. Therefore, this method is recommended mainly for short runs.

2. Occasionally paint will be forced under the stencil, between the stencil and the silk, eventually leaking out onto the printing surface. This can be prevented by fastening the stencil down on all four sides with gummed tape, thus sealing the edges.

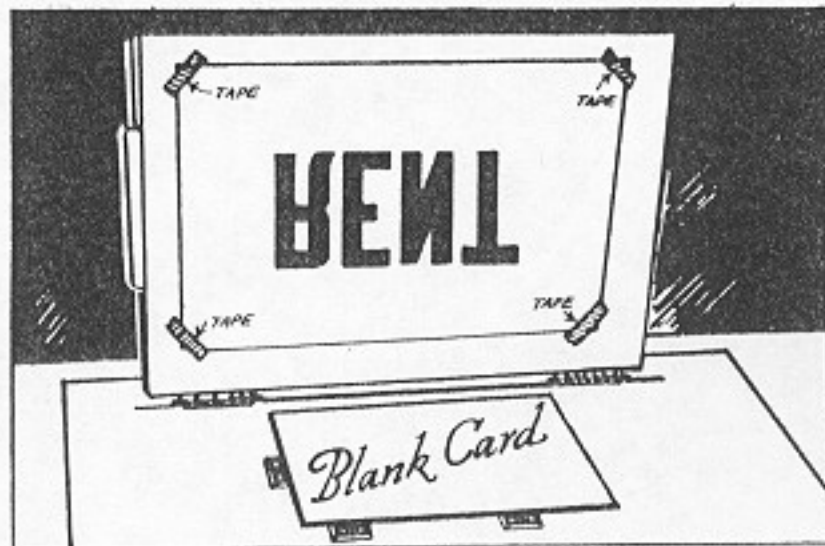


Fig. 79. Blank Card in Position for Printing

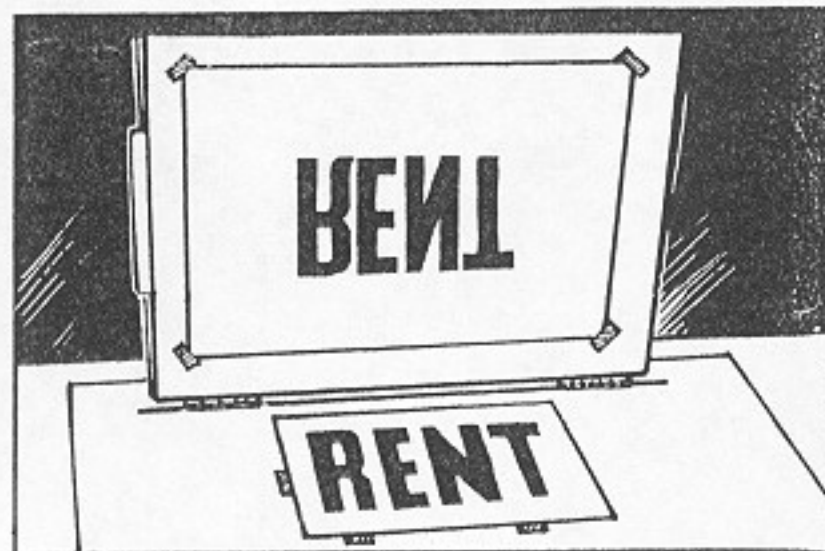


Fig. 80. Printed Sign

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Chapter 7

The Tusche and Glue Method

This method is one of the most popular and practical for the production of inexpensive signs and pictures. Ordinary glue may be used to good advantage. Tusche is a black semi-greasy substance which resembles India ink.

The production of the screen stencil is

possible because when dry, glue is soluble in water and tusche in kerosene, turpentine or gasoline. The copy is painted directly on the screen with the tusche. When this is dry the glue is applied to the rest of the screen area.

After the glue has dried, the screen is rubbed briskly with a cloth saturated with kerosene. The kerosene washes out the tusche but leaves the glue intact. The stencil is then ready for use. The paint will be forced through the areas originally covered with tusche, but will be blocked by the glue in those areas which are not to print.

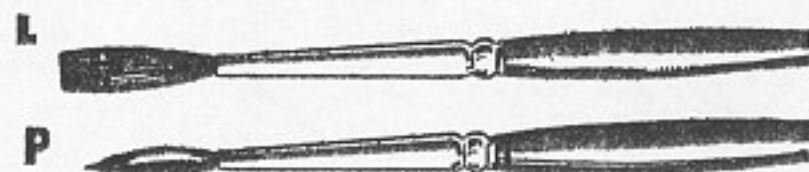
Lacquer may be used as the block-out medium instead of glue. Kerosene has no effect on lacquer, so it and the tusche may



Fig. 81. Cornstarch Solution



Fig. 82. Cloth

Fig. 83. Red Sable Brushes
L - Lettering Brush P - Art Brush

be used together. The use of lacquer is more expensive than glue, however, for it must be removed with lacquer thinner while the glue is soluble in water.

Materials and Tools

The following items will be needed in addition to the regular screen unit:

Cornstarch solution. This should be in proportion of one tablespoonful of cornstarch to one glass or cup of water, Fig. 81.

Cloth. At least two will be needed, one for the water and one for kerosene, Fig. 82.

Brushes. Red sable brushes are preferred. Two will be required, a full brush with a square edge for lettering and a smaller, pointed brush for the design areas, Fig. 83.

Kerosene. To remove the tusche and also to clean the paint from the stencil after

use, Fig. 84.

Glue. It is more economical to purchase this in pint cans, Fig. 85.

Tusche. Tusche may be obtained at supply stores. Buy it in quantity according to your individual requirements, Fig. 86. Tusche can also be obtained in stick form, usually known to the trade as lithographer's crayons, Fig. 101.

Procedure

1. Place the original copy in register under the screen frame, Fig. 87.
2. Lower the screen and accurately trace the original directly on the silk, Fig. 88.



Fig. 84. Kerosene



Fig. 85. Glue



Fig. 86. Liquid Tusche

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3. Remove the screen from the base, place it on props, then on the reverse side apply a coating of the cornstarch solution, Fig. 89.
4. Allow the cornstarch to dry. About one-half hour should be sufficient. Turn the screen basin side up and follow the pencil tracing with the pointed brush dipped in tusche, Fig. 90. Fill in the areas to be printed. Allow to dry for about one-half hour.
5. Place the screen on props, Fig. 91. Pour a small amount of glue into a corner of the screen and spread it across the entire screen surface. A stiff piece

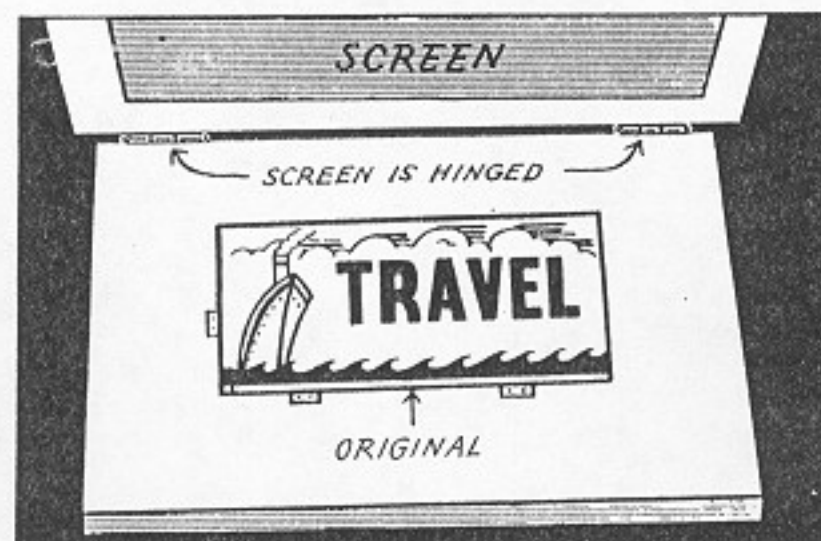


Fig. 87. Original in Position

of cardboard will do the job and may be discarded after use.

6. After the glue is dry, check the screen for tiny holes which may not be covered with glue. Hold the screen in front of a light to make a thorough check, Fig. 92. The pinholes should be closed with a brush dipped in glue.

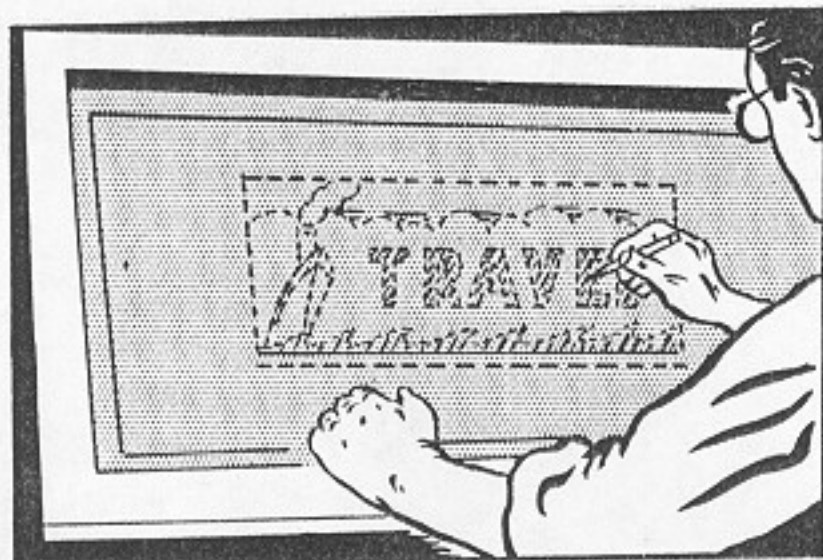


Fig. 88. Outline Design With Pencil

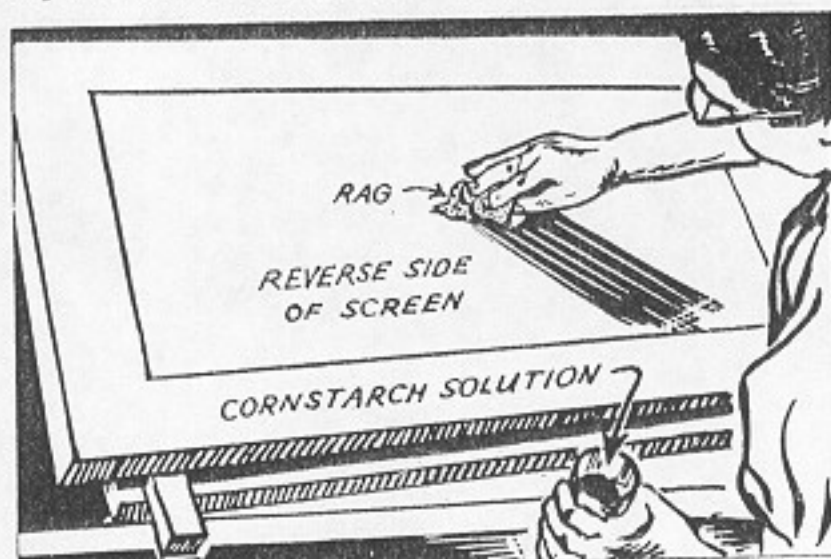


Fig. 89. Apply Cornstarch Solution



Fig. 90. Apply Tusche

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A fan or heater will speed the drying of the glue.

7. Make sure the glue is thoroughly dry.



Fig. 91. Apply Glue to Screen

Hold the screen erect and rub both sides at the same time, using cloths saturated with kerosene, Fig. 93. This dissolves the tusche and causes the corresponding areas of glue to flake off. The tused-in areas of the screen are now open, ready for printing.

8. Sometimes a few particles of glue will still cling to the parts of the screen which were coated with tusche. These may be scraped off with a fingernail, Fig. 94, or removed with a small stiff



Fig. 92. Check Glue Coverage

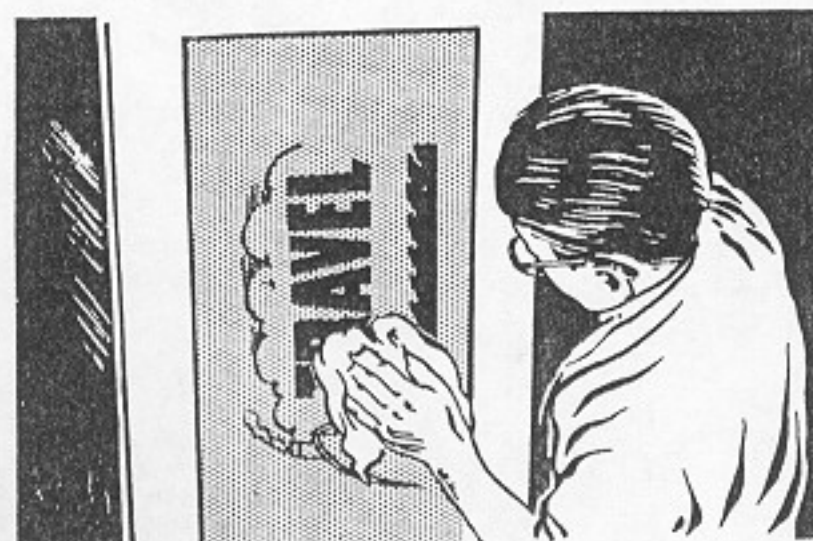


Fig. 93. Remove Tusche With Kerosene

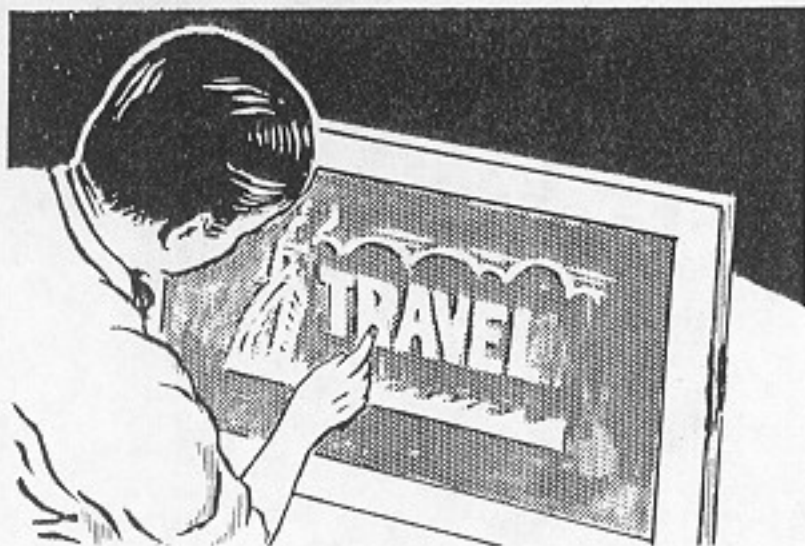


Fig. 94. Remove Stubborn Specks of Glue

brush saturated in kerosene.

9. Again wipe the screen with a cloth saturated with kerosene. Then wipe the screen with a clean dry cloth until it is thoroughly dry, Fig. 95.
10. Re-hinge the screen to the base. The areas of the screen which are to print should match the copy perfectly, Fig. 96.

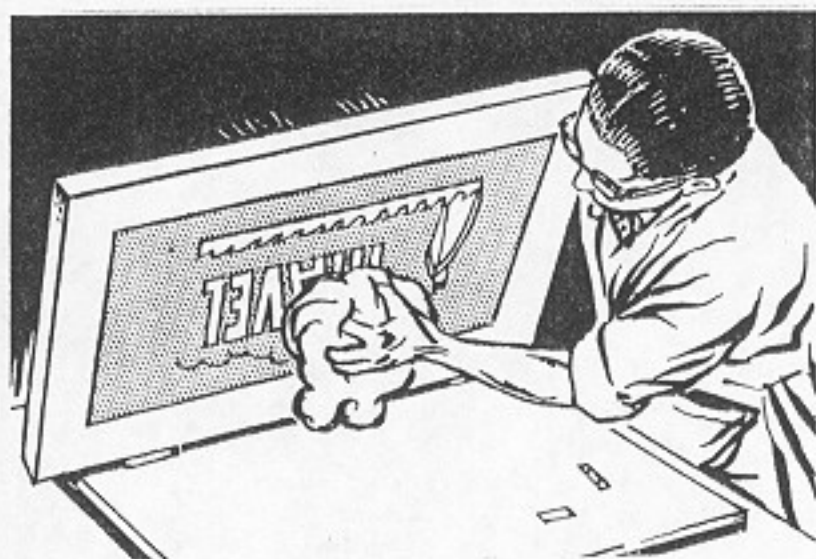
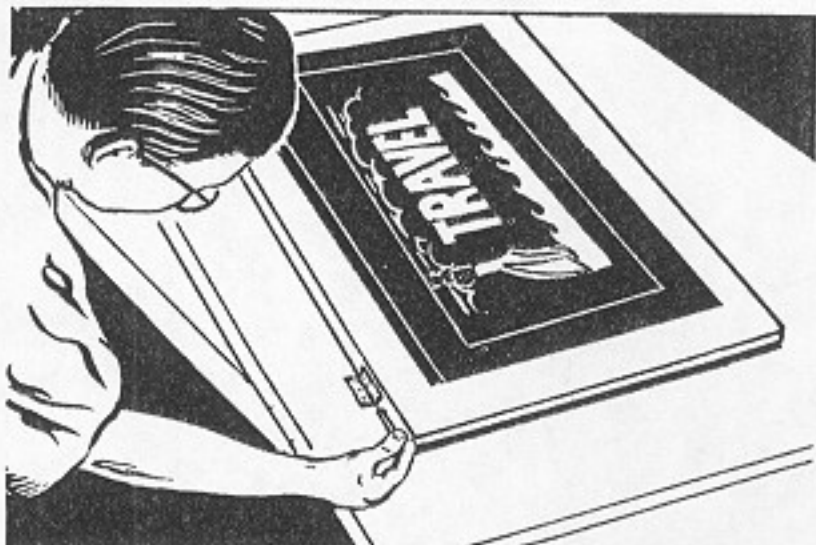


Fig. 95. Wipe Screen With Clean, Dry Cloth

Fig. 96. Rehinge Frame to Base
41

11. Lift the screen frame, insert a blank card in the proper position, and lower the screen. Add the color to the basin



Fig. 97. Pass Squeegee Across Screen

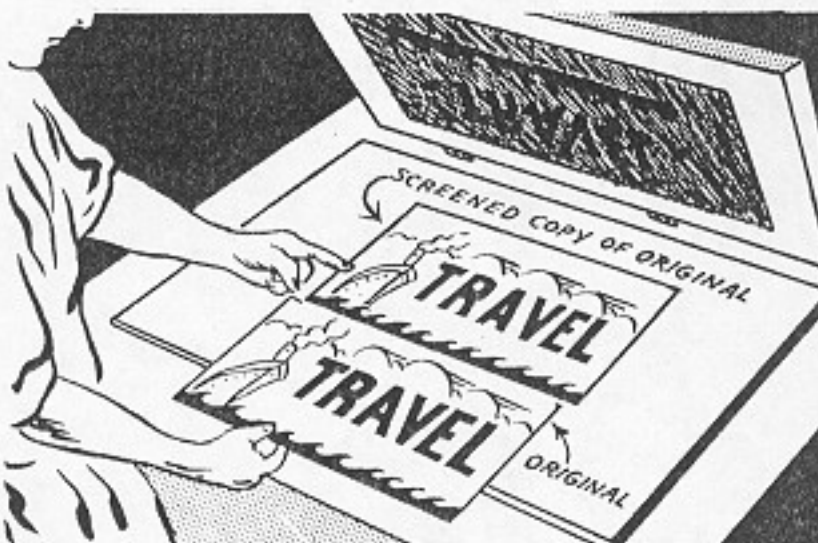


Fig. 98. Screened Copy Exactly Matches Original

and pass the squeegee across the screen, Fig. 97.

12. Raise the screen frame, remove the printed sheet, and insert a fresh card. The print should be an exact copy of the original, Fig. 98.

The tusche and glue method is especially good for pictorial work. It is often used for lettered signs, where the copies are needed quickly or the budget is limited.

Other Resist Materials

Rubber cement. This may be thinned and brushed directly onto the silk in those areas where open meshes are desired on the finished stencil (instead of using tusche). After the glue is applied the rubber cement is easily peeled away leaving the open areas, Fig. 99. This method is especially recommended where large, freeform designs are desired. Some artists work creatively in this manner, directly on the silk, without a pattern.

E-Z Frisquet, Fig. 100. This is the trade name for a smooth, rubber-base product which is used in the same manner as rubber cement. The major difference is that this



Fig. 99. Rubber Cement

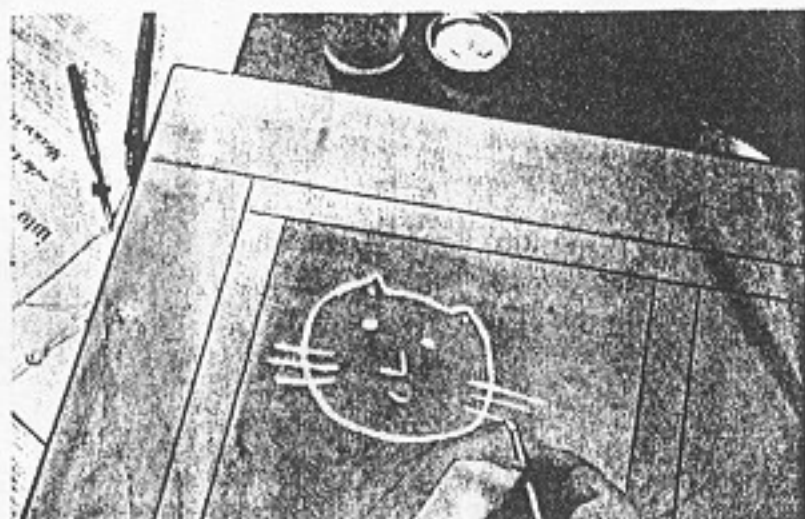


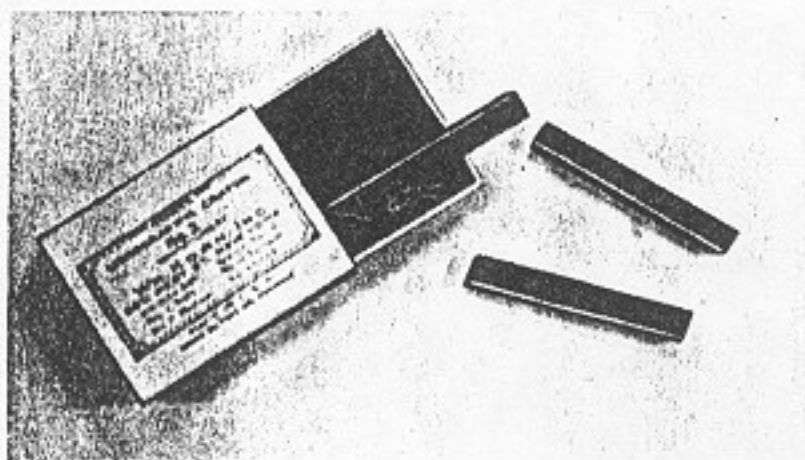
Fig. 100. Using E-Z Frisquet

material can be thinned with water and may be used in a pen as well as applied by a brush.

Grease pencils are sold commercially for writing on glass and china, in a variety of colors. They may be used to draw directly onto the silk. After the glue has been applied the grease deposit is easily removed with kerosene or benzine.

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Lithographers' crayons, Fig. 101. These are used in the same manner as the grease pencils, except the deposit is black and

Fig. 101. Lithographers' Crayons
Courtesy, Wm. Korn, Inc.

much harder, since they are made of solid tusche. Interesting textured patterns can be obtained by using either lithographers' crayon or grease pencil, rubbed over heavy textile. Place a coarse piece of burlap or canvas under the silk; then rub the crayon back and forth on the silk pressing down against the burlap. The result will be a "transfer" of the pattern of the woven burlap. Some areas will have a deposit of crayon; others will not. When the crayon is washed out, the result will be a pattern very similar to the original.

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Chapter 8

Reverse Color Printing

This is probably the fastest method of making a silk screen. It is best adapted to work that can be printed in reverse; that is, the background printed and the lettering or design allowed to show through. The color used becomes the background and the color of the stock becomes the color of the lettering or design.

Ordinary show card color is used as the block-out medium. It is fortified with diluted glue or gum arabic and a few drops of syrup. This makes the mixture more pliable and keeps it from cracking in the meshes of the screen while the stencil is being run. The show card mixture is a free-flowing block-out medium which works easily on the brush.

Materials and Tools

Brush. A good red sable lettering brush is best. See Fig. 83.

Show card mixture. Any good grade of show card color will do the job. White is a heavier, more opaque pigment and therefore makes the best block-out mixture.

Paper. Since the silk screen will be larger than the stock, some block-out medium will have to be used to prevent the paint from spreading beyond the edges of the stock. Newspaper or kraft wrapping paper will do nicely.

Procedure

1. Prepare the show card mixture. The proportions of show card color, glue or gum arabic, and syrup shown in Fig.

102 are approximately correct. The exact proportions should be determined by the consistency of the mixture. If too thick, thin with water plus a few drops of molasses syrup.

2. Raise the screen frame and place the original copy in register, Fig. 103. The register guides may be cut from the printing stock.
3. Lower the screen and make a tracing of the original lettering or design directly on the silk screen, Fig. 104. Use

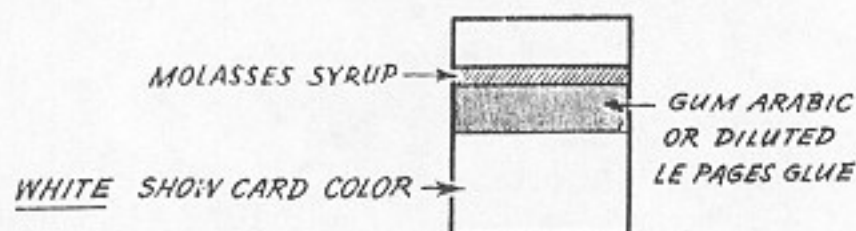


Fig. 102. Ingredients of Show Card Mixture

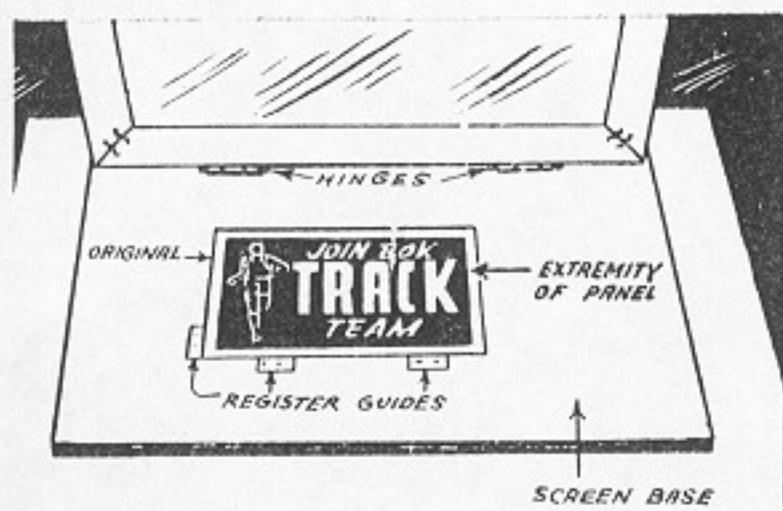


Fig. 103. Original in Position on Screen Base

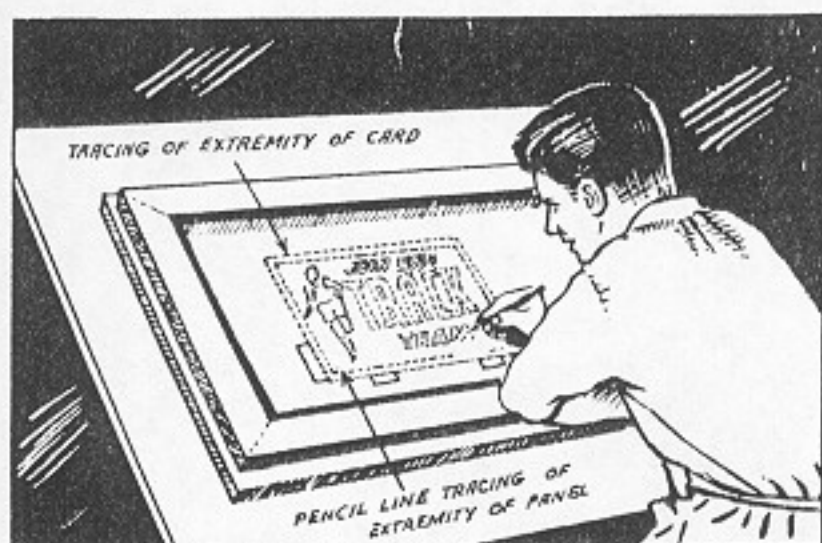


Fig. 104. Trace Design on Screen With Medium Hard Pencil

a medium hard pencil. Trace also the size of stock to be used plus the extremity of the panel.

4. Unhinge the screen frame and elevate it on wooden props. Fill out the pencil tracing on the screen with a red sable lettering brush dipped in the show card mixture, Fig. 105.
5. Rehinge the screen frame. Cut an opening in the sheet of newspaper or wrapping paper to correspond to the extremities of the panel to be printed. (See Figs. 103-105.) This may be rectangu-



Fig. 105. Fill In Pencil Tracing With Brush and Show Card Mixture

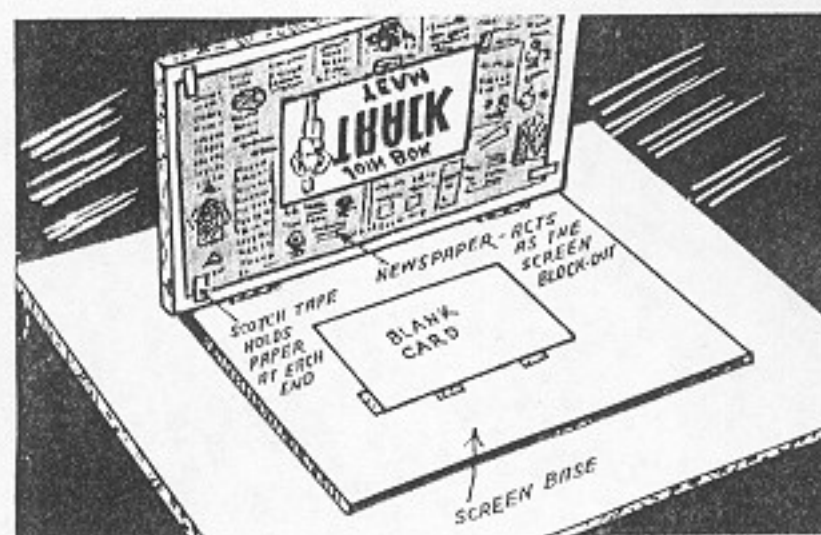


Fig. 106. Mask Screen With Newspaper to Edge of Printing Area

lar, square, circular or oval in shape.

Assuming that the panel is to be rectangular, register the paper on the screen so that the opening coincides with the pencil outline of the panel extremities, Fig. 106. Attach the paper to the screen with cellophane tape or gummed paper. When the screen is lowered, the opening should fall directly over the stock leaving an even margin on all sides.

6. Place a piece of stock in proper position and lower the screen frame. Pour the

properly mixed screen color in the basin and pass the squeegee across, Fig. 107. Both the newspaper and the show card color mixture act as block-out mediums preventing the color from reaching the card surface below. The paint will pass through the meshes of the rest of the screen, printing the background and



Fig. 107. Pass Squeegee Across Screen

allowing the lettering to show in reverse color, that is, the color of the printing stock.

One of the important advantages in using this method is that the entire screen can be cleaned with warm water since all of the materials used are water soluble.

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Chapter 9

Lacquer Film Method

The lacquer film stencil is probably the most used of any of the stencil methods. A wide variety of types of copy may be reproduced inexpensively. A few samples of commercial work done with lacquer film stencils are shown in Fig. 108.

A commercial product is used in making a lacquer film stencil. Several companies manufacture them under various trade



Fig. 108. Samples of Lacquer Film Work
Courtesy, Edw. Lipton

names. They all consist of a glassine, wax paper or plastic backing sheet on which has been sprayed a fine film of lacquer. In cutting the film stencil, it is necessary to cut through the lacquer part of the film without tearing or cutting into the supporting backing sheet. Before the stencil is completed, the lacquer film must be transferred to the silk screen and the backing sheet peeled off. Beginners should experience but little trouble if the directions are carefully followed.

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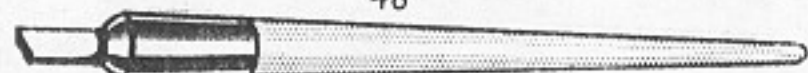


Fig. 109. Stencil Knife

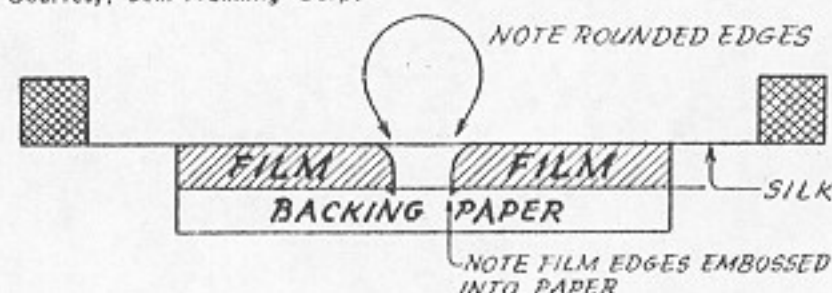
Fig. 110. Oilstone
Courtesy, Behr-Manning Corp.

Fig. 111. Enlarged Section of Film Cut With Dull Knife

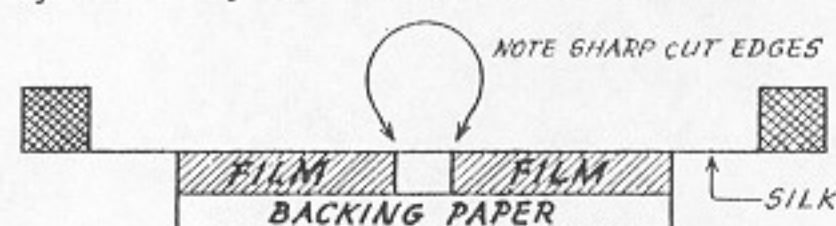


Fig. 112. Enlarged Section of Film Cut With Sharp Knife

Better success will result if the following suggestions are observed:

1. Use a sharp stencil knife and cut with light pressure. The importance of a sharp knife cannot be over-emphasized.
2. Use a clean screen. Use clean cloths to apply the adhering solution.
3. Check the film before adhering it to the screen. Be sure that it is properly cut and that no small pieces of film or specks of dust remain on the film. These would, of course, clog the screen.
4. Slit the backing sheet in the *large* open areas to let the air escape when the film

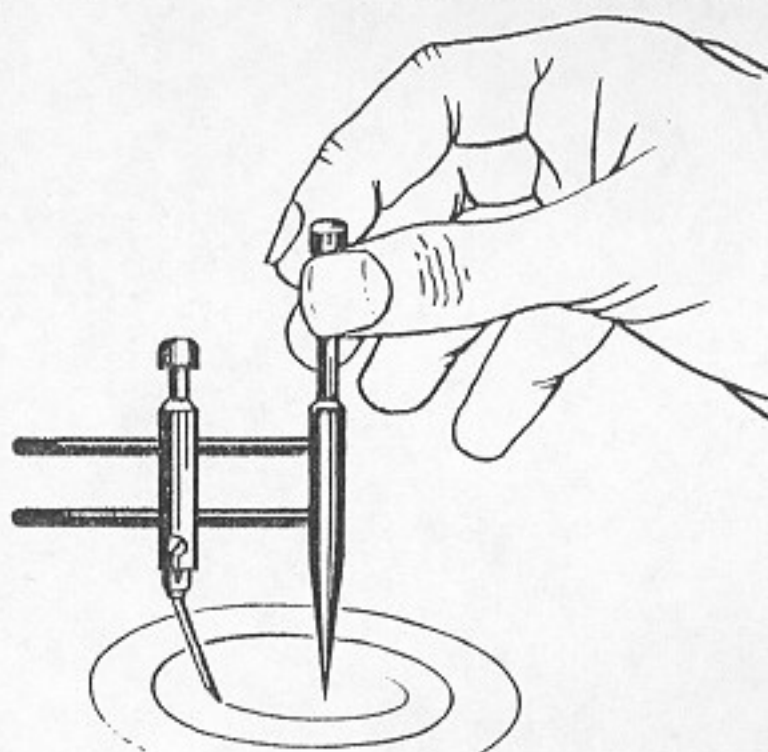


Fig. 113. Circle Cutter

is adhered, Fig. 124.

5. Be sure the film is correctly registered before it is adhered.
6. Work carefully in adhering the film to avoid wrinkles. Start at one side of the film and work consistently up and down or across it.
7. Do not flood the film with adhering liquid. Apply it with the cloth as directed. Too much liquid will spoil the sharp edge of the film.
8. Be sure that the film is properly adhered and dry before removing the backing sheet.
9. Use the adhering liquid recommended by the manufacturer of the film stencil being used.

Materials and Tools

Lacquer film stencil. This comes in rolls but may be purchased by the yard. One yard of it should be sufficient to start.

Stencil knife. Select a handle and blade to suit your needs. Keep the blade sharp at all times, Fig. 109. The knife should cut the film cleanly with very little pressure. An oil stone may be used to sharpen it, Fig. 110. The enlarged cross-section of film in Fig. 111 shows a cut made with a dull knife and heavy pressure. Compare it with Fig. 112, showing a cut made with a sharp knife and light pressure. The film edge in Fig. 111 is embossed into the backing sheet and will be hard to attach to the screen.

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Cellophane tape. Used to attach film to original copy, and also to attach original copy to the drawing board.

Craftsman circle cutter. This device, Fig. 113, makes it easy to cut circles quickly. Keep the cutting edge sharp. If a circle cutter is not available, a substitute may be made by inserting a knife blade into a pencil compass. The knife must be sharp so that it will cut with little pressure.

Drawing board. It is easier to cut a stencil when the copy is attached to a drawing board since it can be moved to get the best possible light and most comfortable position, Fig. 114.

Straight edges. A metal edge ruler, triangle and T-square will be needed, Fig. 115 A, B, C. The ruler and T-square are used to draw horizontal lines, the triangle and T-square together to draw vertical lines. If possible, these instruments should be made of metal, since they will be used to guide the knife blade in cutting straight lines.

Cloths. Several clean cloths will be needed for wiping or cleaning the screen.

Block-out lacquer. This will be needed to fill in the meshes of the screen around the film, Fig. 116. Wrapping paper or paper tape may also be used.

Lacquer thinner or cleaner. This will be needed to clean the film from the screen after the printing is completed, Fig. 117.

Adhering liquid. Use the type recommended by the manufacturer of the film being used, Fig. 118.

Kerosene. This is, of course, needed to clean the paint from the screen, Fig. 119.

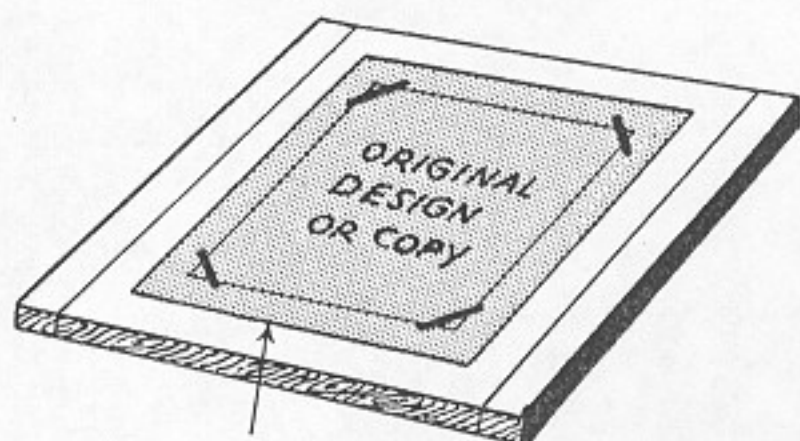


Fig. 114. Film in Position Over Original

Procedure

1. Fasten the original copy to a drawing board or to the work table with thumb tacks or tape, Fig. 114.

2. Using pencil or ink draw a small cross in each of the four corners of the original. These are register marks and will

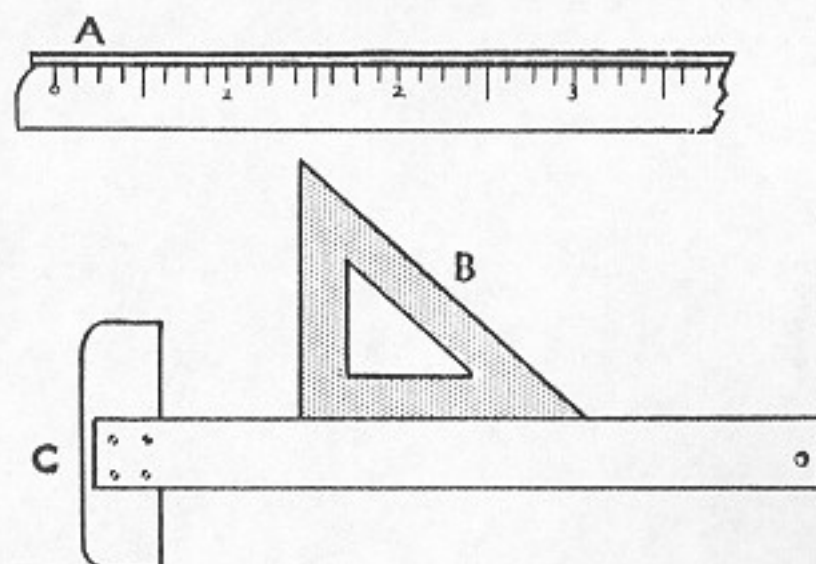


Fig. 115. Straightedge, T-Square, and Triangle



Fig. 116. Block-Out Lacquer



Fig. 117. Lacquer Thinner



Fig. 118. Adhering Liquid

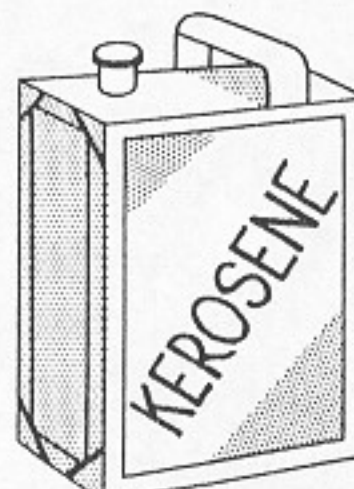


Fig. 119. Kerosene

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help replace the film in exact registration.

3. Cut a piece of film large enough to cover the area of the original that is to be reproduced in the first color printed. The lacquer film is rather expensive, so the smaller the piece used for the job, the less it will cost.

4. With cellophane tape fasten the film, lacquer side up, to the original drawing. It should be held securely.
5. Using the film knife, trace cut register cross marks on the film to coincide exactly with the marks on the original drawing.
6. Using the T-square, make all of the horizontal or vertical cuts, Fig. 120. Angular cuts may be made with the ruler to guide the knife, or with the

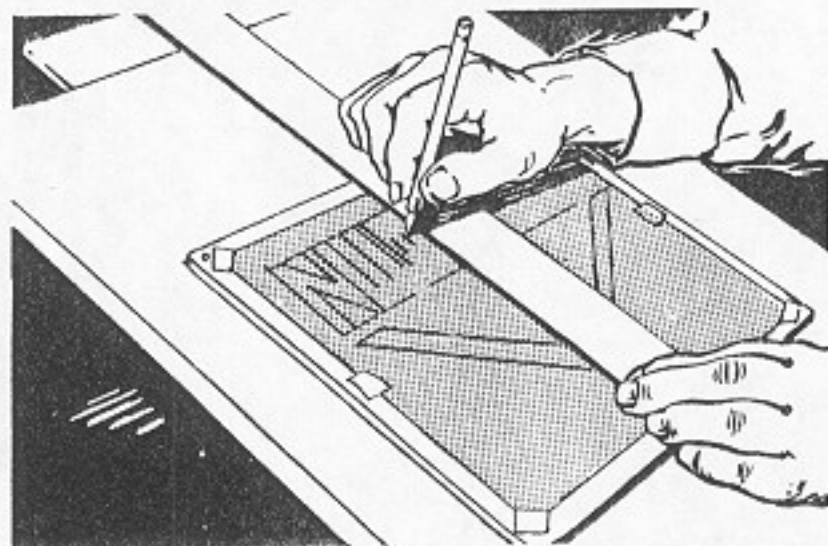


Fig. 120. Carry Straight Cuts Beyond Intersection

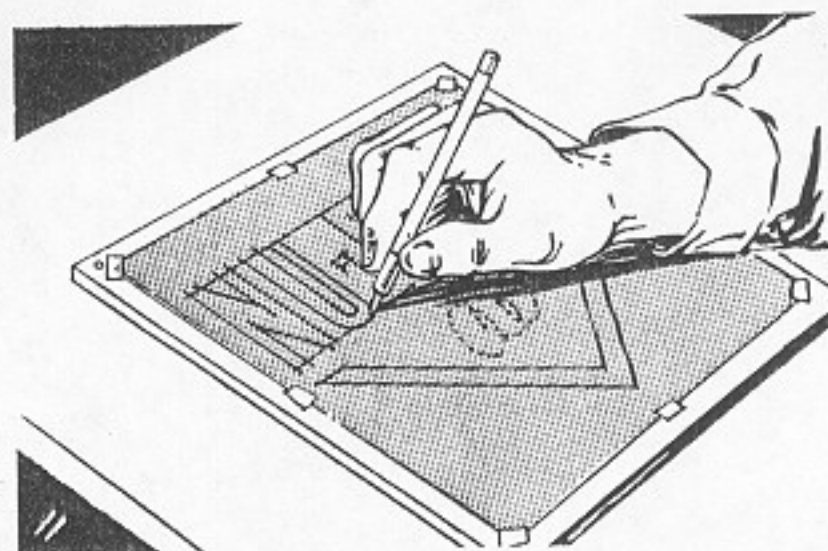


Fig. 121. Curved Cuts

triangle and T-square as a guide. Vertical cuts also may be made with the triangle and T-square as a guide. Note that the vertical cuts extend above and below top and bottom lines. See Fig. 121. Curved cuts may be made freehand as shown in Fig. 121, or with the aid of a French curve. Circles and arcs should be cut with the circle cutter, Fig. 123. *Cut through the film only.*

7. If the job is to be run in two or more colors, it will be necessary to allow a

small color overlap in order to obtain proper registration when running the job. In opaque color work, the lightest color is printed first; for example, yellow, then red, and then black. About 1/32 of an inch should be sufficient overlap.

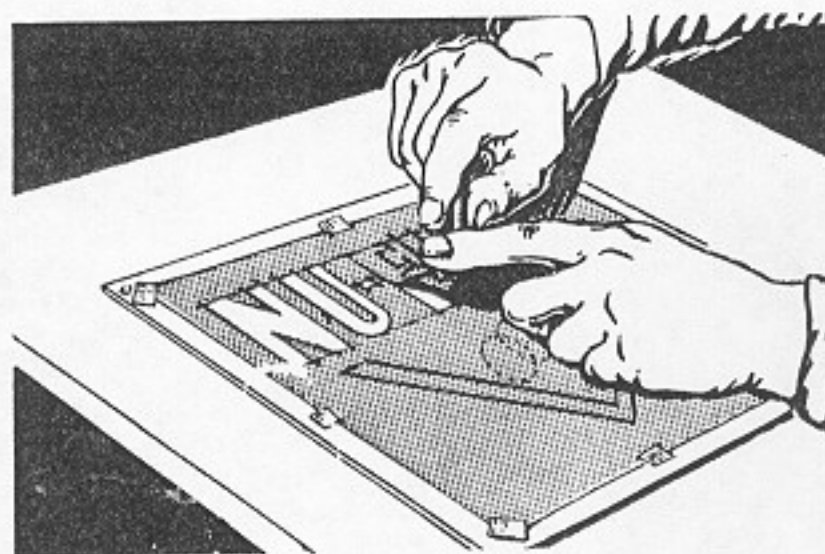
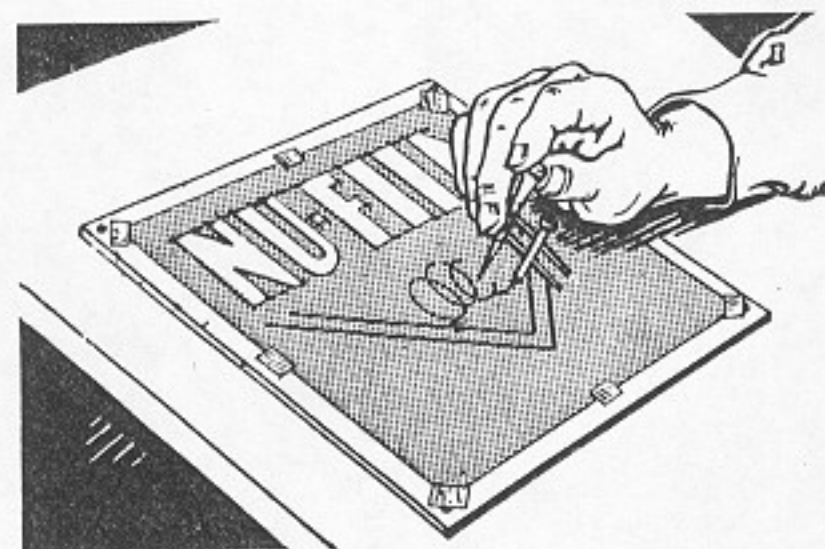


Fig. 122. Removing Film

Fig. 123. Circle Cutter in Use
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With transparent screen colors, the darker colors are printed first. If, for example, a red is first printed and partially overlapped with a yellow, the result will be three colors, red, yellow and a "free" orange where the yellow was superimposed over the red.

8. Peel the film from the cut portions. A tweezer or knife blade that is somewhat dull may be better for removing the film than a sharp blade, Fig. 122.
9. If there are large open areas in the design, cut a small slit through the backing paper to let the air escape during the adhering operation, Fig. 124.
10. The film for each color may be applied

separately to the screen then printed before the other colors are cut, or all of the colors may be cut before any of them are applied to the screen. Better register may be obtained if all of the films are first cut and the register of each succeeding film checked against the previous print of the other. Any errors in register may then be corrected on the film before adhering it to the screen.

A very simple but accurate register-cutting device is shown in Fig. 125. A piece of film is cut out for each color. All pieces of film are cut to the same size. The original design or copy is fastened to a drawing board as shown in Fig. 114. The entire set of cut pieces of film is then placed over the design. Three long "bank pins" or corsage pins are then driven vertically through all pieces of the film and into the drawing board. The corner pin (in the upper left-hand corner of the illustration) serves as a pivot pin.

To cut the film for the first color, carefully remove the upper right-hand and lower left-hand pins, leaving the pivot pin in place. Swing aside all pieces of film except the one directly in contact with the original copy. Replace the two pins removed, to hold this lower piece of film. Proceed with the cutting of the film for the first color. When complete, remove the two edge pins again, slide aside the first color film which is now cut, and slide into place the next piece of film. Replace the pins and continue. Proceed in this manner until all the films have been cut. When using this device each successive film will be cut in precisely the same location. Each can be carefully checked against

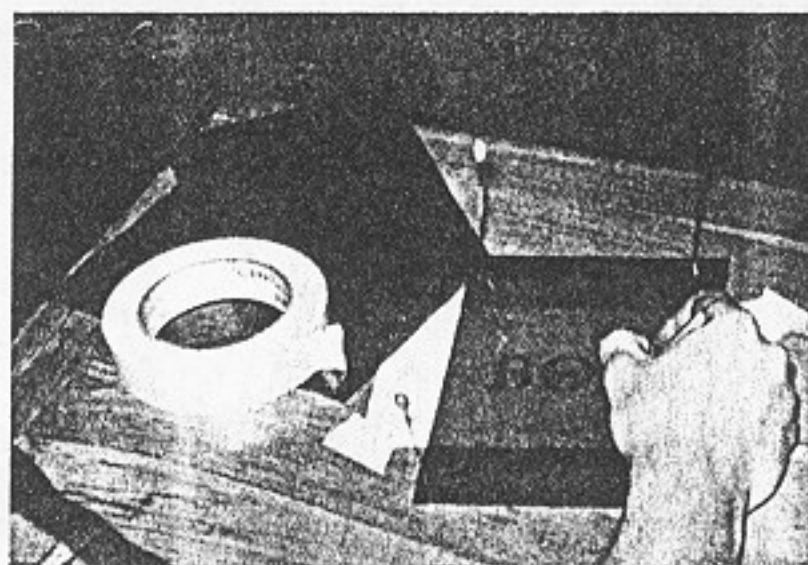


Fig. 125. Simple Device for Register Cutting

the original copy and each can be checked against the others (because of the film's transparency).

11. Prepare a screen to receive the lacquer film. If the silk is new, wash it with water to remove the sizing, dry it with a cloth, and then wash it with lacquer thinner or adhering liquid to remove any other foreign matter.
12. Place the screen frame in the hinges of the base. Position the original copy under it and set the register guides,

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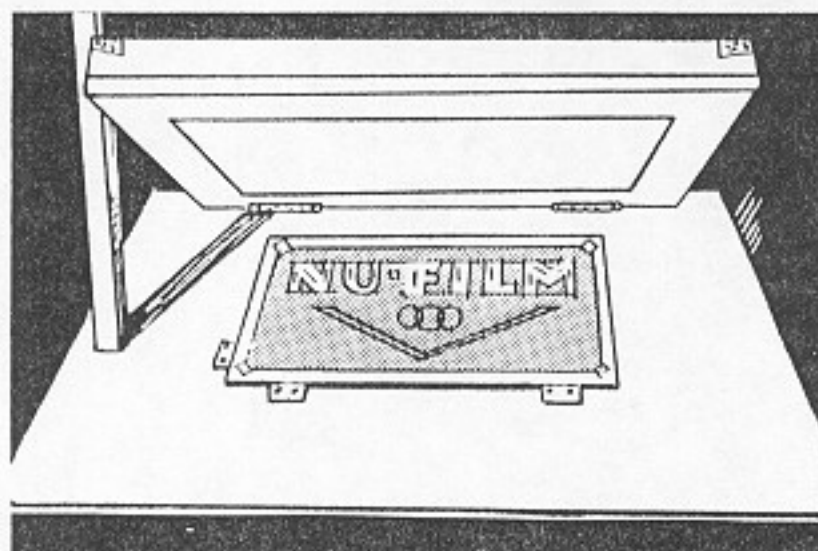


Fig. 126. Film Ready to Adhere

Fig. 126. Fit the cut film for the first color to the original and fasten it to the copy with cellophane tape. Use the register marks (four crosses) to fit the film precisely in place. Examine the film very carefully to be sure that all pieces of cut film have been removed.

13. Lower the screen frame.
14. Moisten a cloth thoroughly with adhering liquid. Starting in the upper left-hand corner, wet a small portion of the

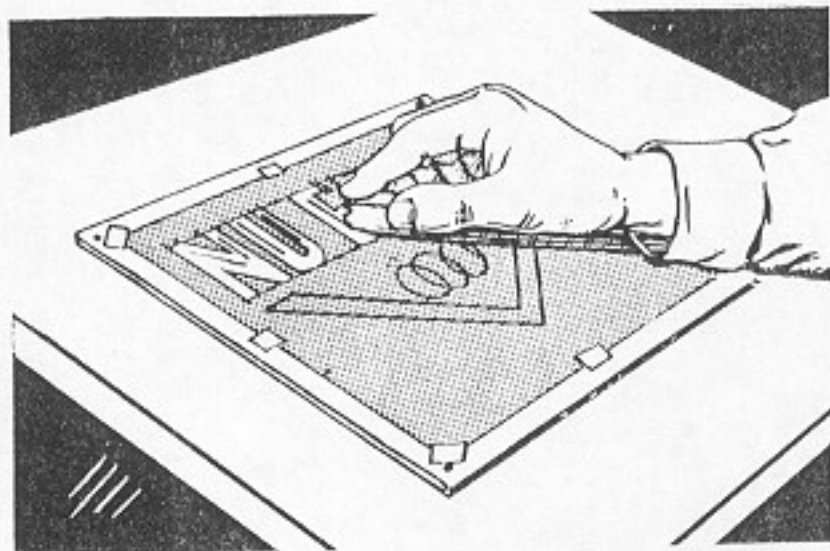


Fig. 124. Slit Backing Sheet to Allow Air to Escape During Adhering

screen with a *single stroke*. Dry it immediately with a dry cloth held in the other hand, Fig. 127. Wet one patch, dry it, then wet another small patch in the numerical order shown in Fig. 127. The patches should not be larger than about six or seven inches square.

15. Continue wetting small patches, drying them immediately. Use a light rubbing motion to dry the screen and continue rubbing until all of the adhering liquid has evaporated, Fig. 128. Work up and down one end of the screen, then make another row of patches.
16. When all of the film has been adhered, take a thin straight edge or ruler and slip it between the film backing sheet and the original drawing. Free the backing sheet from the original drawing by loosening the tape. This also frees the screen.
17. Remove the screen frame from the hinges and lay it on the table, backing sheet side up. Allow the film to dry thoroughly; about ten minutes is usually sufficient time.

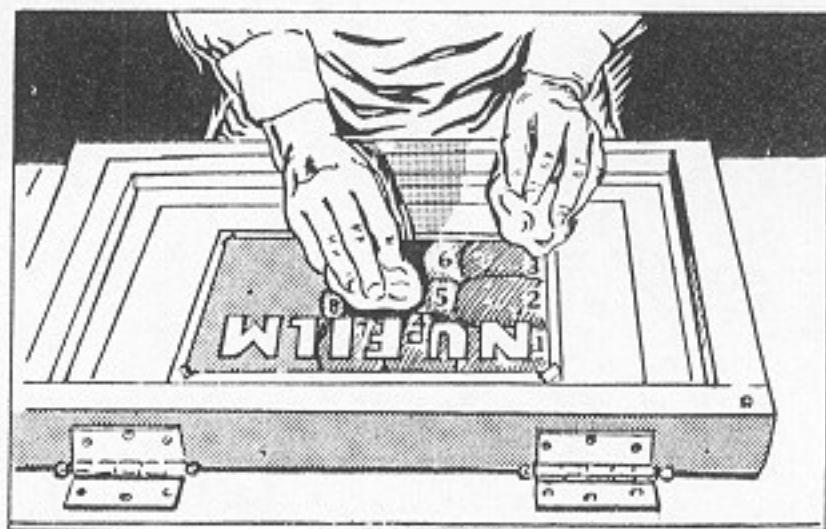


Fig. 127. Adhere the Film

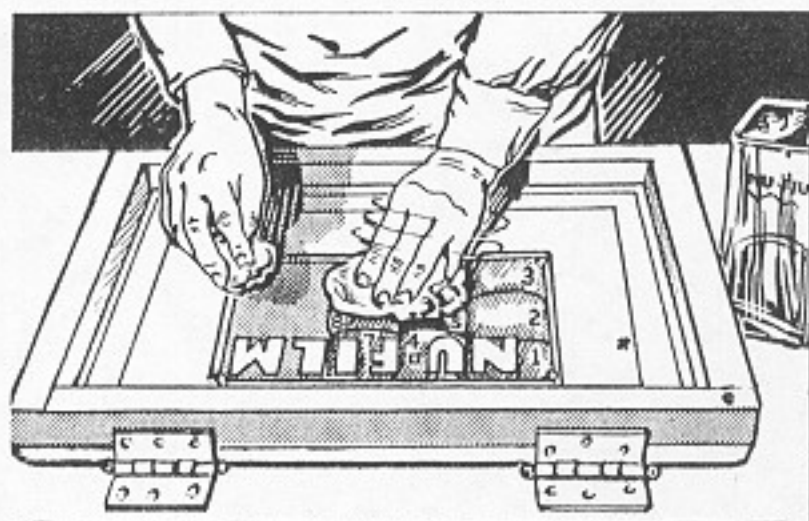


Fig. 128. Moisten Small Area and Immediately Dry

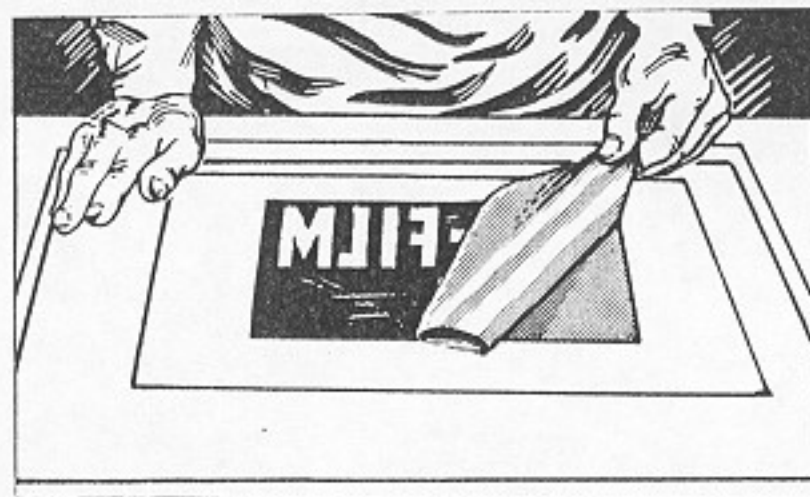


Fig. 129. Remove Backing Sheet

18. Start at one corner and slowly peel the backing sheet from the film, Fig. 129.

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Peel the backing sheet in such a manner that the film can be seen at all times. If part of the film was not completely adhered, stop and complete that operation.

To adhere a small spot of the film, turn the screen over and wet and dry that portion again.

19. When the backing sheet is removed, check the film to see that it is properly adhered. If there are loose places, turn the screen film side up, and dampen the loose part with adhering liquid. Apply this liquid from the opposite side of the screen and pat the film in place with a finger.
20. Fill in the screen mesh around the film with block-out lacquer or mask it with paper.
21. Rehinge the frame and print the job.
22. When the run is completed, scoop up the excess paint with a piece of cardboard. If the stencil is to be used again,

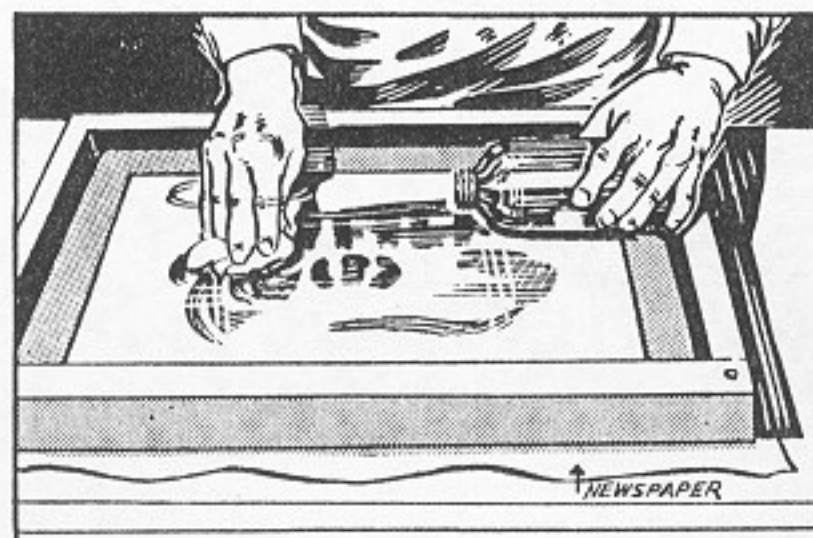


Fig. 130. Remove Film from Stencil

then it must be thoroughly cleaned following the instructions in step 24 below and those given in Chapter 14. Care must be exercised to prevent damaging the lacquer stencil when wiping over it with the kerosene-dampened cloth. If the stencil is not going to be used again then remove the screen frame and place the screen on several thicknesses of newspaper. The film should be in contact with the newspaper.

23. Saturate a piece of cloth with lacquer thinner and rub it over the film portions of the screen, Fig. 130. After a few minutes, lift the frame and pull the newspaper away from the screen. Do this once or twice and it should remove nearly all of the film, Fig. 131.
24. Moisten two clean cloths with lacquer thinner and wash the silk from both sides at the same time. Dry the silk with a clean cloth and the screen is now clean, ready for the second color.

Special Film Materials

A number of special film materials are available and the student and home craftsman should be familiar with them because they increase the scope of his work. Most of them are approximately the same in cost, so there is a definite advantage in purchasing the kind which will best fit the job.

Plastic-back. Most conventional lacquer films are paper-backed. Unless otherwise specified on an order, the paper-backed will be furnished. Plastic-back film is easier to cut because it has a firmer backing and there is less likelihood of accidentally cutting through the backing. It is not affected

by weather conditions because it does not shrink or expand. It peels away from the backing much more readily than paper-back even in damp weather. All the films mentioned in this section are produced in both paper backing and plastic backing.

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Blue film. This film is blue rather than the conventional amber color. Viewing an original design through this film gives much better color values. Therefore it is particularly advantageous to use it when preparing stencils for multicolor work where each color has to be separated and cut on a different stencil.

Green film. Similar in qualities to the other films but some people find the green color more restful for their eyes when working on large stencils for long periods of time.

Matte finish. A film with a dull finish rather than the usual glossy finish. Creates less glare on the surface while working.

Lacquer proof. A special film for use when lacquer is the pigment to be used for printing. Naturally, if lacquer film were used, the lacquer pigment would dissolve the stencil. Lacquer pigments are used more and more because of their quick-drying qualities.

Water soluble. A film that is adhered with a special adhering liquid, but which can be removed from the screen with warm water. This is a definite advantage and reduces the cost of large quantities of washing lacquers. This film can also be used with lacquer pigments.

Extra weight films. Where an extremely heavy deposit of paint is required, such as when printing on canvas or in preparation for flocking or beading a design, this film is recommended. It is available in several extra weights.

These films are produced by various manufacturers and each has a specific trade name for the type he makes. When ordering, it is best to describe the use to which the film is to be put. It is also strongly advised that the adhering liquid recommended by the manufacturer be used, for there are slight differences in chemical make-up.

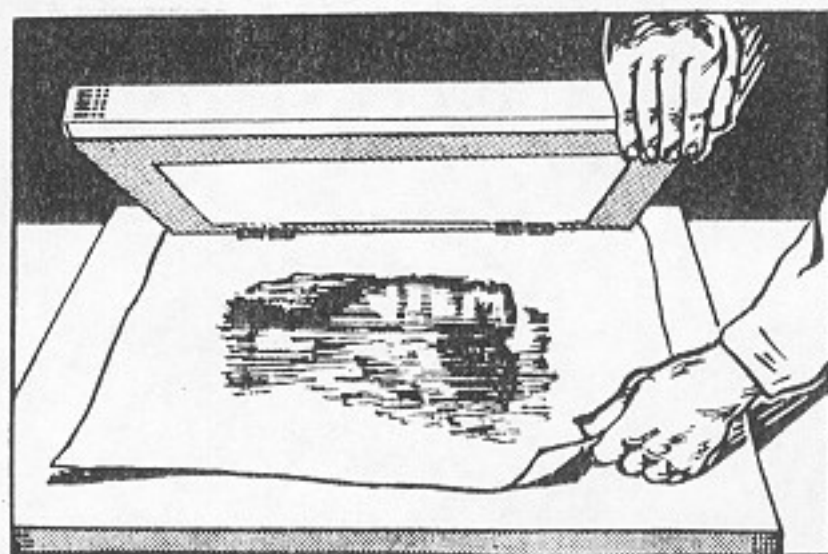


Fig. 131. Dissolved Film Adheres to Paper

Chapter 10

Indirect Photographic Method

In brief, the procedure in making a stencil by the indirect photographic method consists of sensitizing a prepared gelatin film, exposing it, developing it, and then transferring the gelatin to the silk screen. The method depends on the impregnation of the gelatin film with a bichromate solution. The gelatin areas which are exposed to light harden and remain in the film; those not exposed are washed out in the developing and fixing. The areas which are washed out represent the open spaces in the screen through which the paint will be forced by the action of the squeegee.

Materials and Tools

For this method a finer mesh of silk is required, No. 16xx or 18xx being generally used. If silk is new, the sizing should be removed by scrubbing with a brush and warm water.

One of the newer metal meshes will be even better to use for the photographic techniques. The special gelatin films employed seem to adhere better to these meshes. One factor is extremely important — the cleanliness of the screen. It is best to use a new fabric, regardless of the kind. Failing this, if kerosene or some other mineral spirit has been used for cleaning, the mesh should be thoroughly cleaned with lacquer thinner and air dried for several hours before attempting to adhere a photographic, gelatin stencil.

Photographic positive. A photographic positive is somewhat similar to a snapshot negative, except that it is reversed, i. e., the image appears opaque on a transparent or translucent background. For black and white line work, a photographic positive may be made by drawing the design with photographer's opaque or jet black India ink directly on heavy tracing paper, clear or transparent celluloid, acetate sheet or specially prepared translucent materials called *Dul-Mat* or *Trace-O-Line*. If the material to be

reproduced is a photograph, wash drawing, or painting, the imperceptible gradation of tone values requires a screened positive. For silk screen work, such a screened positive should be no more than an 85-line value. A photoengraver will be able to make such a positive.

Gelatin transfer film. The transfer film is sold by the yard, in sheets and in rolls. There are several brands available. All consist of an emulsion of gelatin and other ingredients evenly distributed over a thin transparent acetate or pliofilm backing. The manufacturer of each gelatin film usually supplies instructions covering exposure time, distance of film from light source, intensity of light, and type of bulb to be used. It is wise to follow the instructions for the film being used.

Sensitizing solution. This liquid makes the film sensitive to light. Some sensitizers are sold in solution, ready-made, others come in powder form and can be mixed a little at a time as needed. For *best results* the dealer will furnish the especially prepared sensitizer applicable to the brand of film used. To insure chemical efficiency, fresh sensitizer should be used each time. Any mixing necessary should be done in a *dark* room and the mixed liquid stored in an amber-colored bottle.

Light bulb. For most purposes, a No. 2 photo-flood bulb is best. It should be used with a reflector and placed from twelve to eighteen inches from the positive, depending upon the size of the subject. The exposure time will vary according to the type of positive, intensity of light and type of film used.

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Again, the manufacturer supplies instructions for the different situations.

Printing frame. The gelatin transfer film will be exposed in the same manner as a contact print. A printing frame consists of a glass mounted in a wood frame and a cover. The positive is placed against the glass, the film is placed against the positive, gelatin side up, with the smooth side against the positive, and the cover is placed in position, Fig. 139. The frame is then locked together with a set of clamps and the film exposed.

In lieu of a printing frame, a rubber mat and a piece of heavy glass may be used. Place the mat flat on a table top. On top of the mat place the film (smooth side up, gel-

atin side down). Then place the positive in position in reverse (as seen in a mirror). The sheet of heavy glass is placed on top of the positive, keeping it firmly in contact with the gelatin film. All of these operations should be carried out in semi-darkness to keep from exposing the sensitized film, Fig. 140.

Other items. It is best to have the following tools conveniently at hand: electric fan for drying the film, porcelain basin for

2. The next step is to make the photographic positive of the original. To make the "R" and the border a positive tracing on *Dul-Mat* or acetate sheet is

⁵⁵ all that will be needed. Lay the *Dul-Mat* or tracing paper over the original and tape it in place. Using a brush or a pen and jet black India ink or photographers' opaque, draw directly on the *Dul-Mat*, Fig. 134.



Fig. 132. Actual Size Reproduction of Silk Screened Halftone (65-Line Screen)

washing the film, and a camel's hair brush, two or three inches wide, for applying the sensitizing solution to the film.

Procedure

1. Assume that an "R" is to be reproduced on an 11" x 14" card in one color. The poster is to have a line border as shown in Fig. 133.

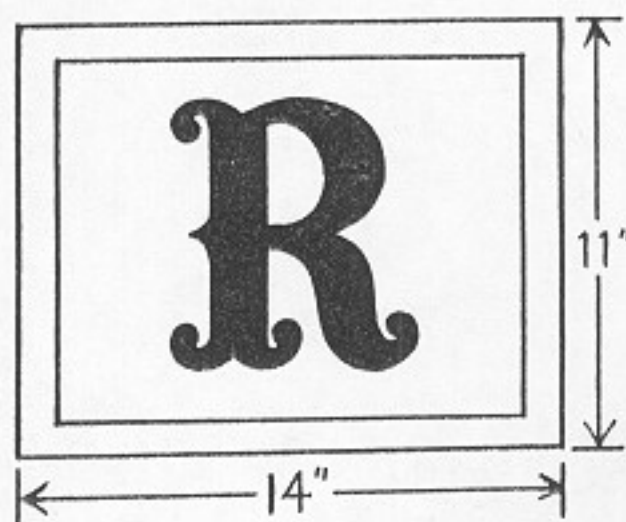


Fig. 133. Block "R"

Copy involving intricate detail such as small type, fine pen and ink drawings, etc., can be sent to a photo-engraver or photo-offset printer for a photographic positive. For photographs and shaded copy a 55-, 65- or 85-line screened positive will be required depending on the amount of detail sought in the finished print. A 65-line screen

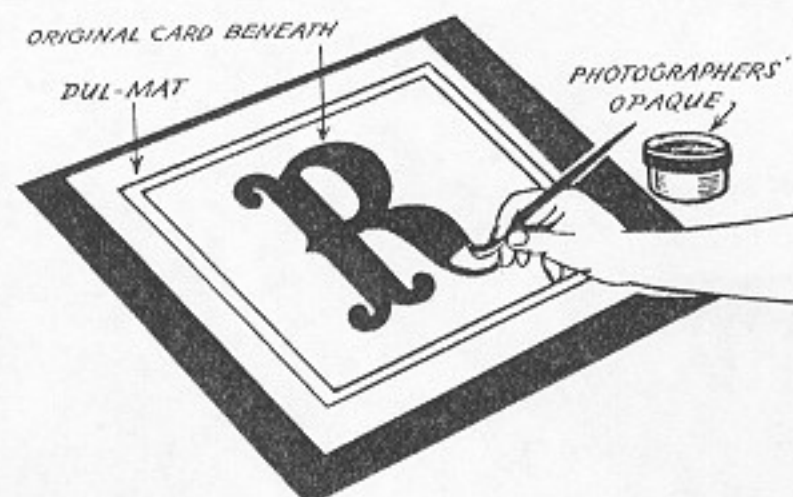


Fig. 134. Make the Photographic Positive on Dul-Mat

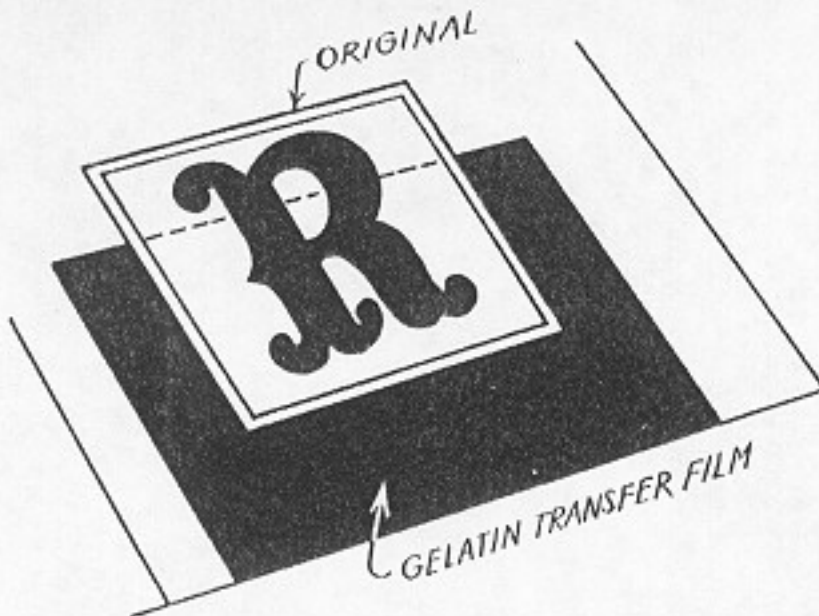


Fig. 135. Determine the Size of Film Required

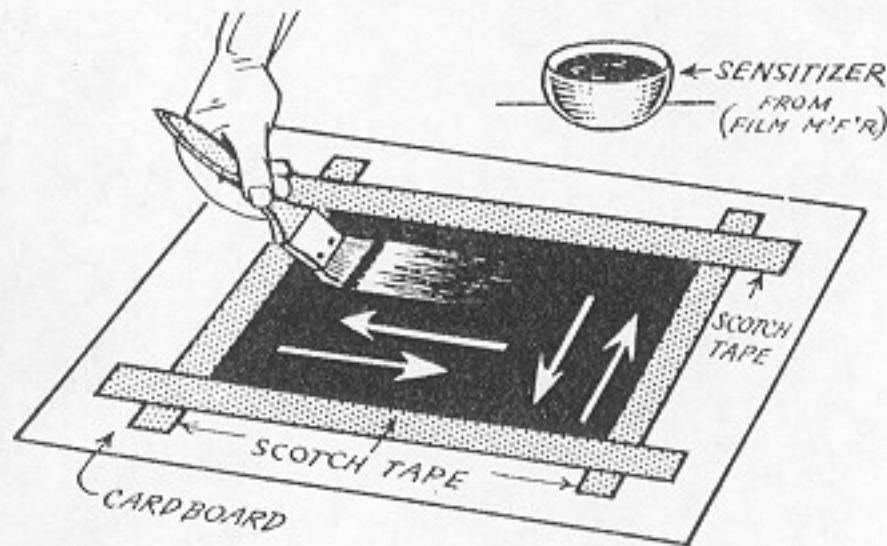


Fig. 136. Sensitize the Film

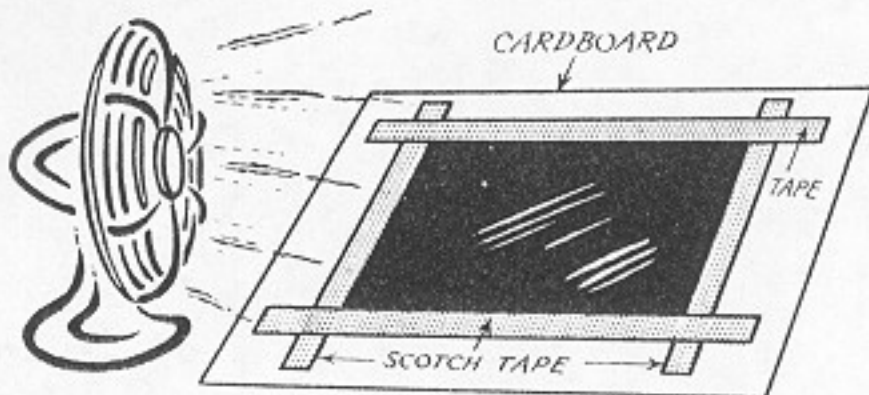


Fig. 137. Dry the Sensitizer

positive fulfills the average job requirement and is mostly used. Fig. 132.

3. Cut a piece of gelatin film. It should be larger than the original copy; about three inches on each side is good margin, Fig. 135.

NOTE: Be sure to use fresh film as the film deteriorates with time.

4. Lay the film on a piece of heavy cardboard, gelatin side up. Tape all four edges, Fig. 136. Brush on several coats of sensitizer, using a soft, wide camel's hair brush. Work across the width, then

across the length of the film. Work in subdued light and keep the brush fully charged with the sensitizer.

5. Keep the film in the dark away from sunlight, electric lights or any dust while it is drying. An electric fan may be used to speed the drying. With the fan, about fifteen minutes will be required, Fig. 137.
6. Cut the sensitized film inside the tape, using a razor blade, Fig. 138.
7. Place the positive in the contact frame next to the glass. The "R" should be in its normal position. Then place the

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sensitized film in position, gelatin side up. Place the printing frame cover over the film and lock the printing frame, Fig. 139. Make the exposure.

If a printing frame is not available, use the set-up shown in Fig. 140. Note that the film is placed next to the rubber mat, gelatin side down, and the pos-

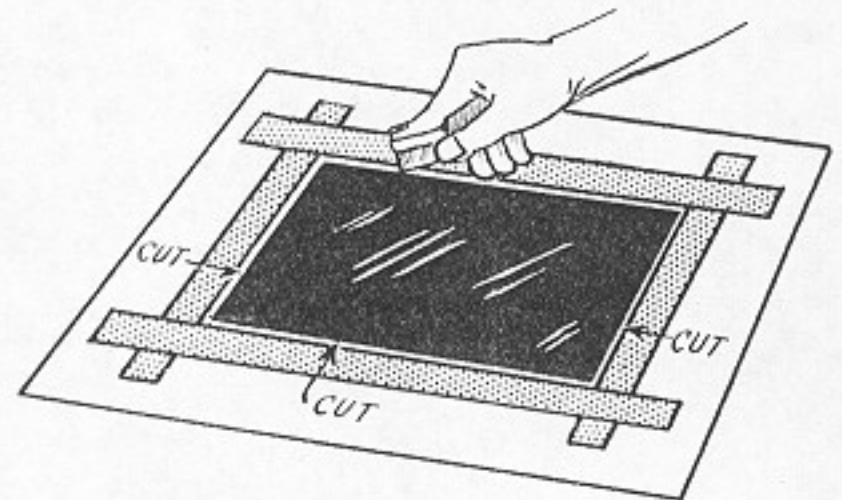


Fig. 138. Cut the Sensitized Film

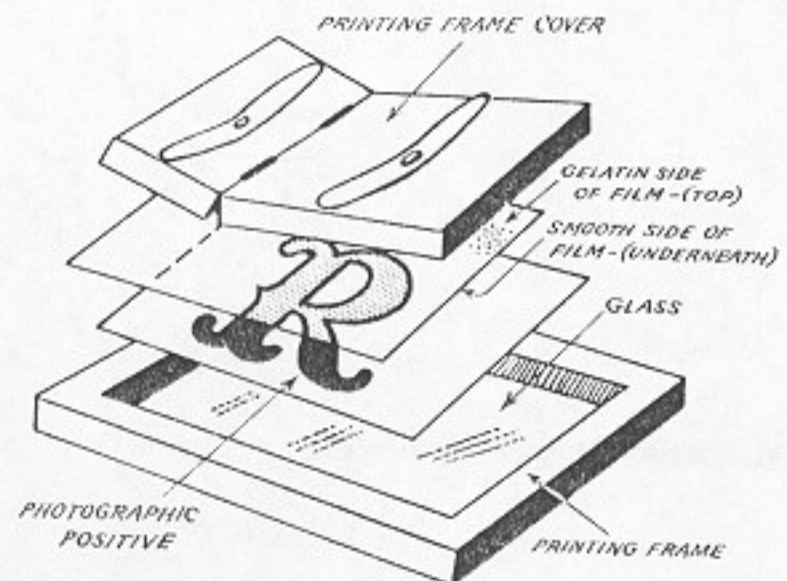


Fig. 139. Assemble the Printing Frame

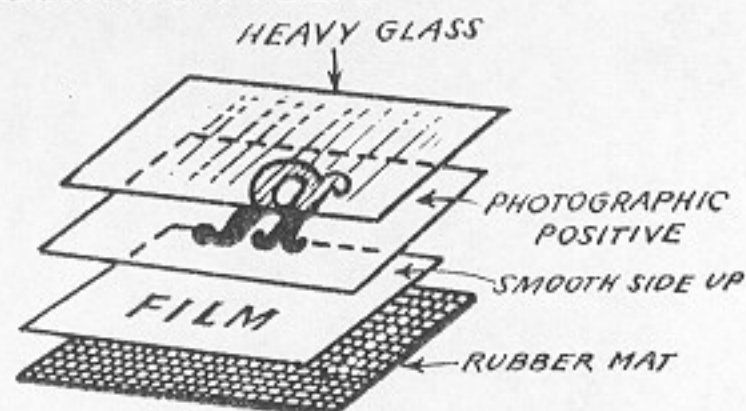


Fig. 140. Use of Table Top for Printing

itive is placed in position on the film with the "R" in reverse image.

8. Suspend a No. 2 photo flood lamp twelve to eighteen inches from the printing frame, Fig. 141. The distance from the frame is determined by the size of the area to be exposed. Turn the frame glass side up and expose the film for $1\frac{1}{2}$ to 3 minutes. The exact time will depend upon the distance from the light to the film. A little experimenting will soon enable you to determine the exposure required. Film manufacturers will include tables along with their film. Generally, exposure time is governed by several factors:

- A. Less exposure time is needed when light is strong.
- B. Less exposure time is needed when positive is very transparent. When the positive is made on translucent material, the exposure time must be increased.
- C. Less exposure is required for fine detail work or screened areas.
- D. The exposure time must be longer as the distance from light to film

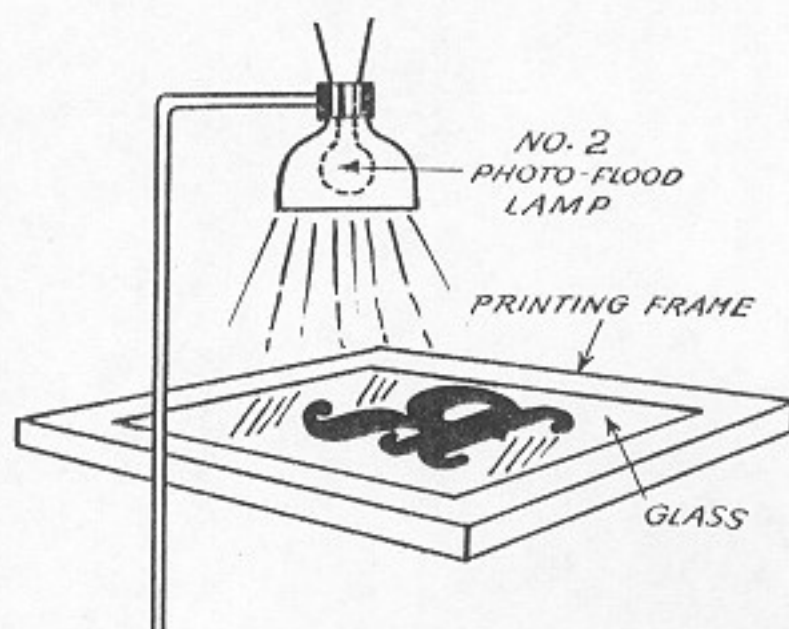


Fig. 141. Expose the Film

is increased.

9. When the exposure is completed, turn off the light and remove the film from the printing frame. Place it in warm water, (about 115°F.) and gently agitate it as development takes place, Fig. 142. The unexposed areas of the gelatin which were protected by the corresponding opaque areas of the positive will dissolve and wash out. The exposed or remaining gelatin areas which received the light, harden and are not affected by the action of the warm water. About five minutes should be sufficient development.

10. Now place the film flat on a sheet of glass or cardboard and pour several cups of warm water over the open areas of the film, Fig. 143. This will remove any particles of gelatin which remain in the

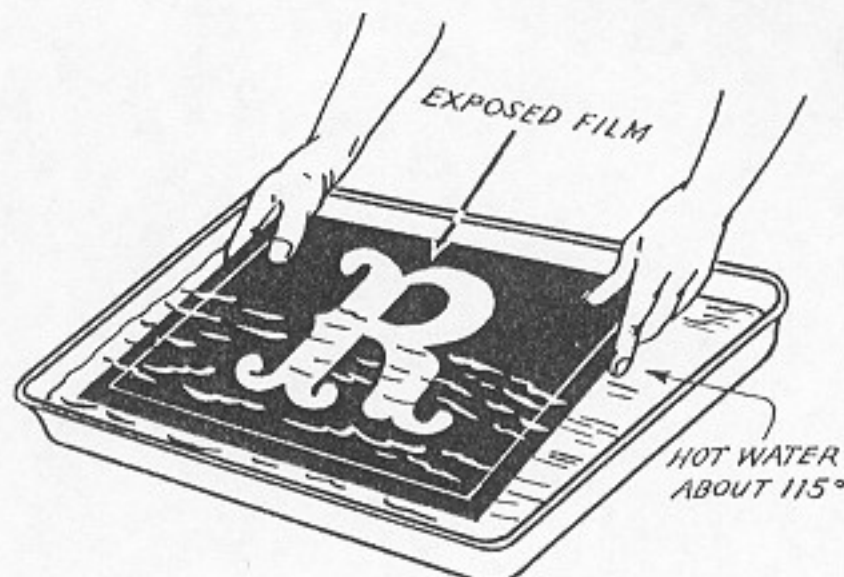


Fig. 142. Wash the Film

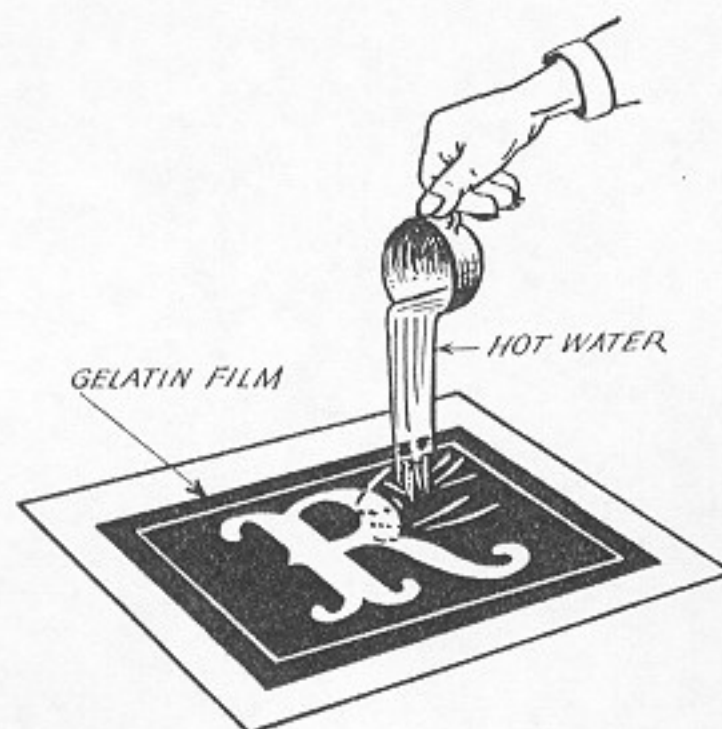


Fig. 143. Spray Film to Remove Stubborn Spots

open areas. Wash the film for a few minutes in cold water to fix the gelatin in place.

CAUTION: Gelatin melts at a low temperature, so the water should not be near the boiling point, or it will melt the exposed areas of the film.

11. Place the wet film in register on the screen base, gelatin side up, Fig. 144.
12. Lower the screen frame. Place a newspaper over the silk and rub the paper gently, Fig. 145. The newspaper will absorb the excess moisture through the screen, and at the same time the pressure will cause the film to adhere to the

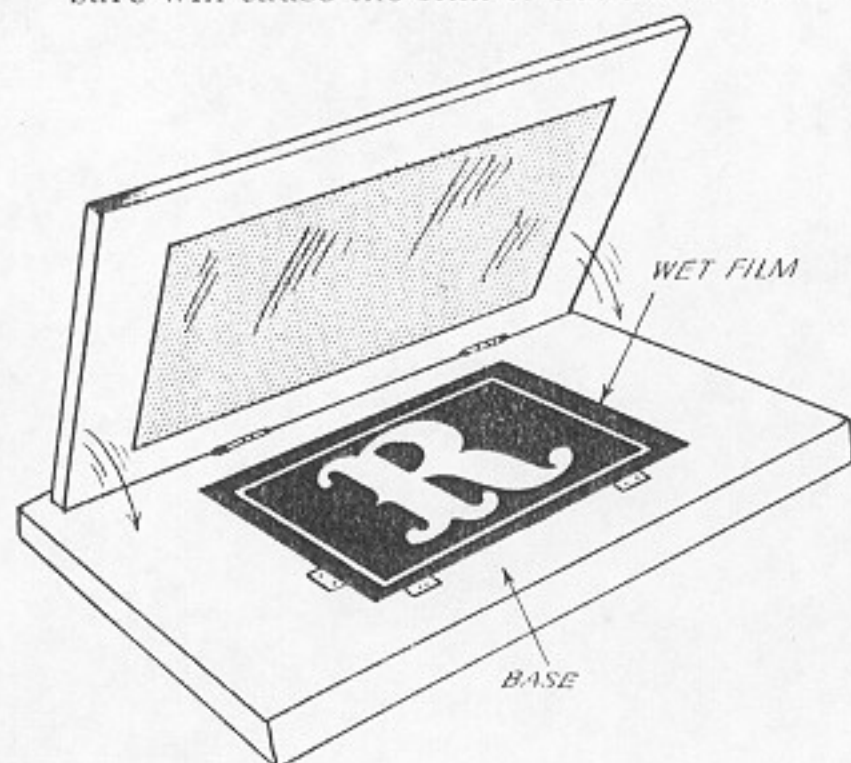


Fig. 144. Place Film in Register

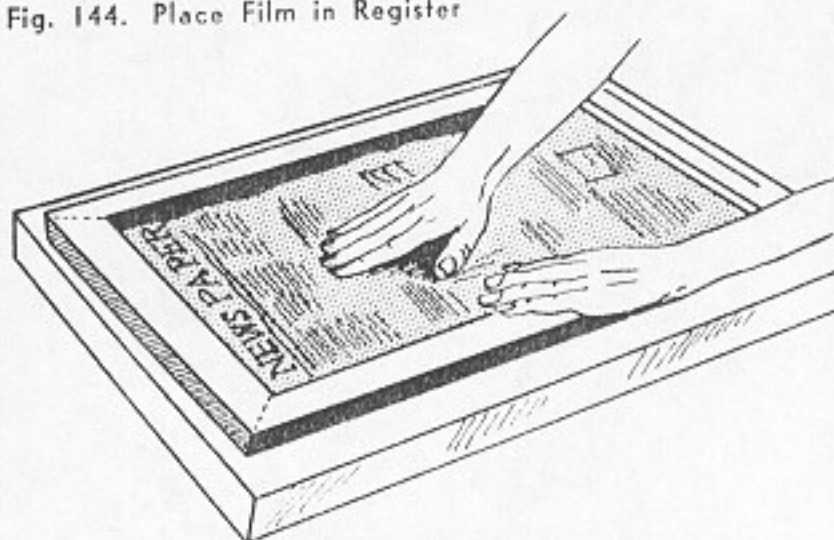


Fig. 145. Adhere the Film
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silk. Repeat the blotting with newspapers until no additional moisture can be removed.

13. Unhinge the screen and prop it in a vertical position in front of an electric fan, Fig. 146. Direct the flow of air from the fan against the screen for

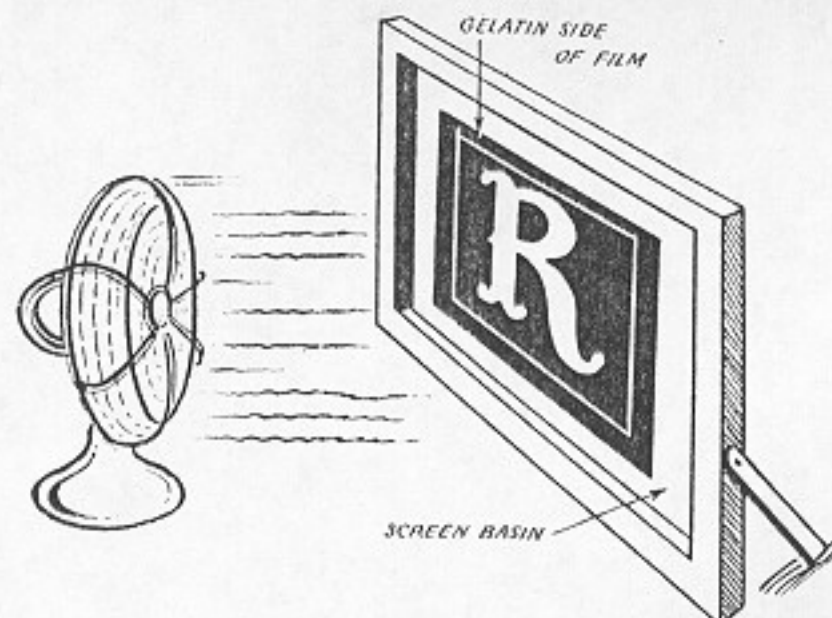


Fig. 146. Dry the Film

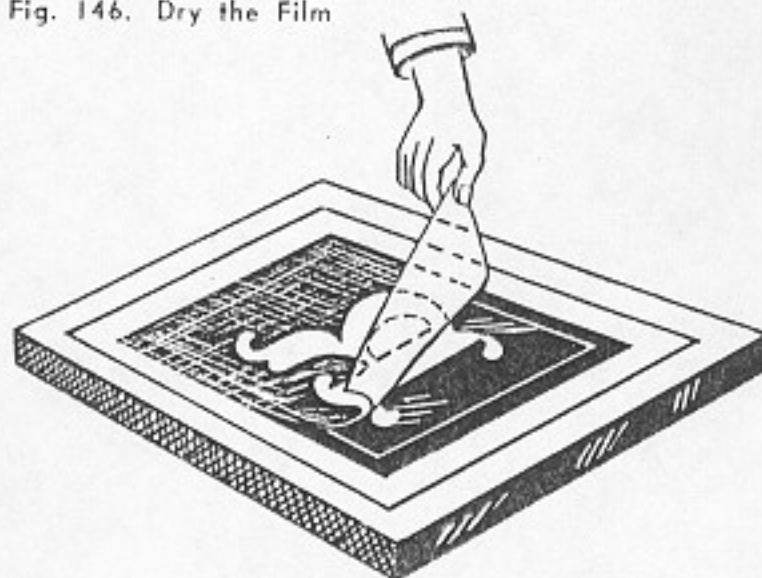


Fig. 147. Remove the Backing

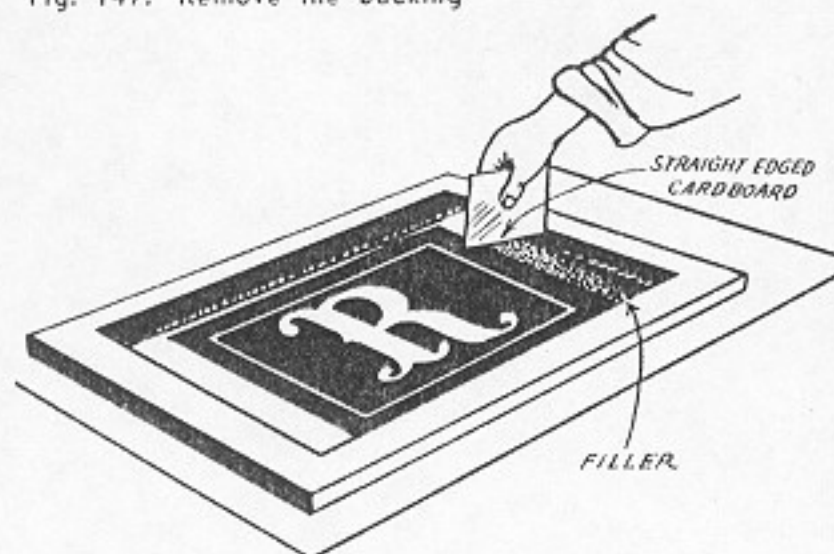


Fig. 148. Block Out the Screen Around the Film

about fifteen minutes, or until it is thoroughly dry.

14. After the film is thoroughly dry, reverse the screen frame and gently peel the transparent film backing away from the gelatin, Fig. 147. Work slowly and use great care not to tear the gelatin around the open areas.
15. Rehinge the screen and block out the open meshes of the silk around the edge of the film. Block-out lacquer, glue, or

gummed tape may be used as a filler, Fig. 148.

It is recommended that a special, water-soluble, block-out filler be used. When such is used the entire screen can be washed out with warm water. This eliminates the necessity for washing out the stencil with water and the filler with lacquer thinner.

16. When the block-out medium is dry, raise the screen frame, place a blank card in position, and begin printing.

Cleaning the Screen

When the necessary number of copies have been made, the excess paint should be scooped up with a piece of cardboard and placed back in the paint container. The silk may be cleaned with a cloth saturated with kerosene and then gone over with a dry cloth until the screen areas are completely free of paint. The filled-in spaces around the gelatin stencil, Fig. 148, may then be dissolved with the appropriate solvent; water will remove glue, while lacquer thinner will dissolve block-out lacquer. The gelatin screen stencil part is then scrubbed on both sides of the screen with warm water and a stiff hand brush. This removes the gelatin areas of the screen. The screen should now be totally clean and ready for use again.

See Chapter 14 for more information on cleaning of screens.

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Pre-Sensitized Films

Several pre-sensitized, indirect photographic films have appeared on the market each of which seems to have certain advantages. In a pre-sensitized material the overall advantage is the elimination of the steps of sensitizing and drying gelatin film. Since both of these processes are time consuming and the final results are somewhat uncertain, the introduction of these new materials is a great boon to home and school craftsmen.

Ektagraph, product of the Eastman Kodak Company, is not only pre-sensitized but contains its own developer, requiring the use of just an *activator*. It can also be handled completely in low-intensity incandescent light. This is especially important for home and school use.

The process may be summarized as follows:

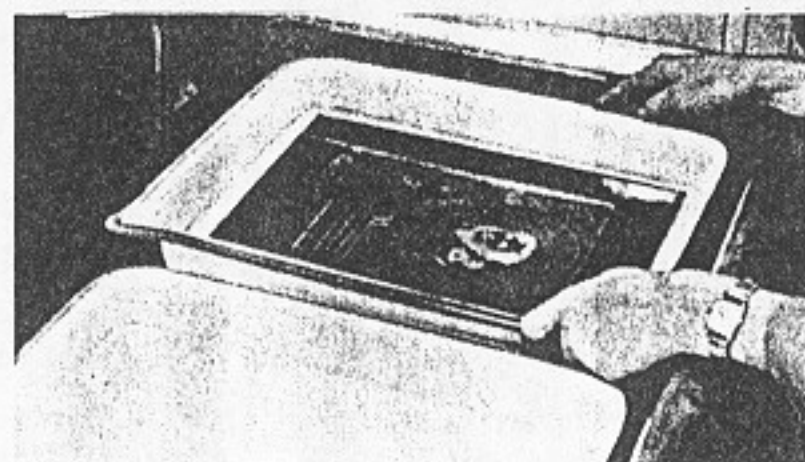


Fig. 149. Develop Pre-Sensitized Film at 68° F.

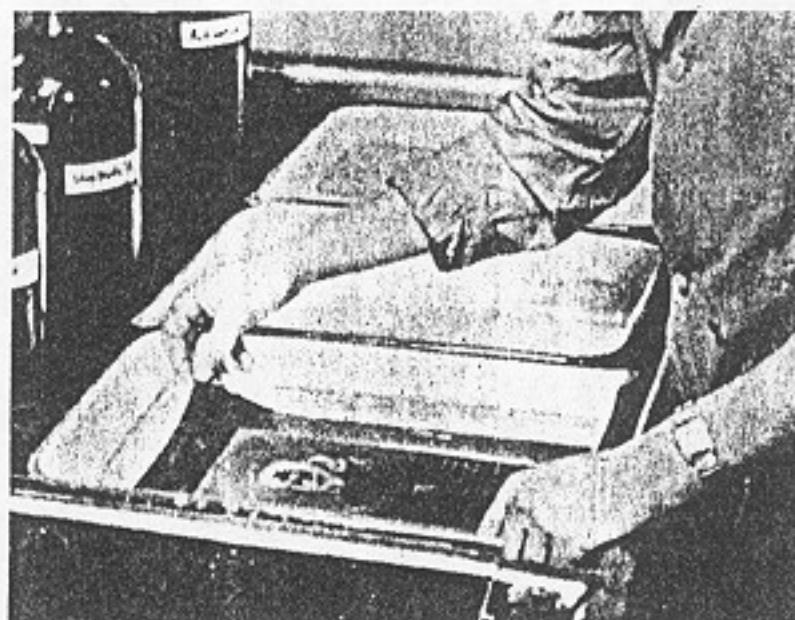


Fig. 150. Stop in Two Baths for 30 Seconds Each

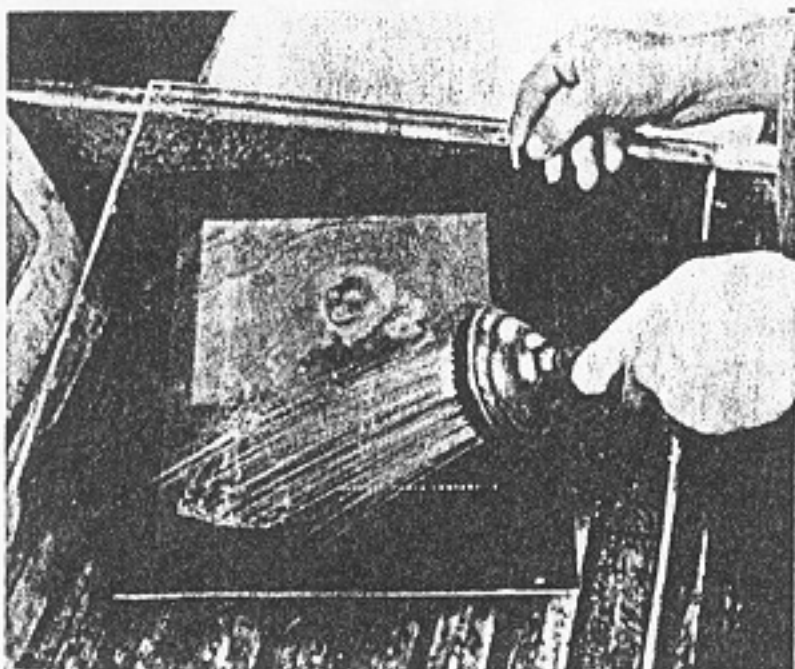


Fig. 151. Wash in Spray Bath

1. The film is exposed through the back of the sheet in the same manner as the other types of indirect films. Exposure is made with a simple reflector-flood lamp and only a short exposure is needed.
2. After the exposure, the film is placed

in the activator solution, Fig. 149. Development takes place in 1 to 1½ minutes at 68°F.

3. Immediately after development in the activator the film is placed in two stop bath solutions for 30 seconds in each, Fig. 150.
4. The unexposed, non-hardened areas of the film are then washed free by placing the film, emulsion side up, on a sheet of glass and spraying it with water at approximately 100°F. This step is similar to that in processing the conventional type of photographic process film except that a spray bath is recommended, Fig. 151.
5. The film is then adhered to the screen in the manner shown in Fig. 145. It is advisable that the screen be wet. Drying is best accomplished by using a combination of heat and circulating air, Fig. 152. The heat in the illustration is furnished by a bank of infra-red lamps overhead. Many of the usual types of gelatin photographic films cannot be subjected to heat. This type can, providing the air is kept circulating.
6. When the film is completely dry, both sides are liberally moistened with a special *stripping solvent*, Fig. 153.
7. The back is then stripped off, Fig. 154, open areas on the screen are blocked out and the screen is ready for printing.

The total time from exposure of the film to placing it on the silk ready for drying, is less than twenty minutes. The film is available in packages of 25 sheets in sizes from 8 x 10 inches to 24 x 30 inches. The

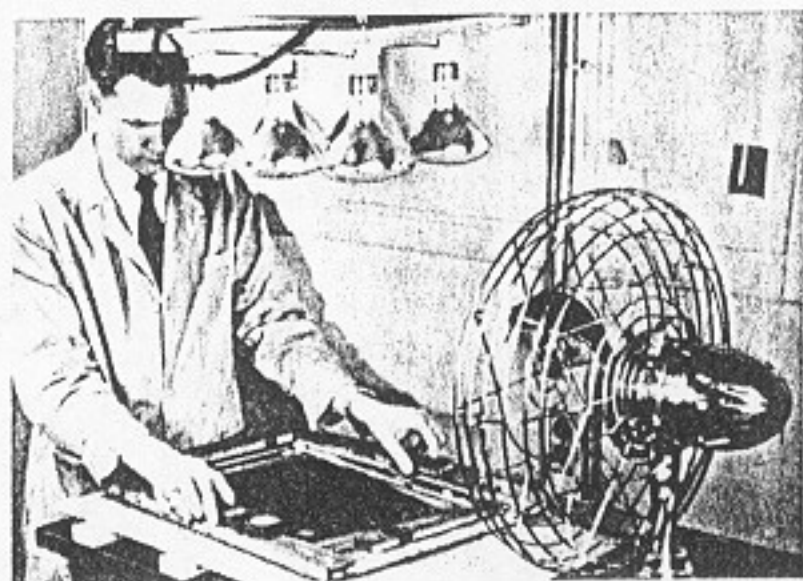


Fig. 152. Adhere to Screen in Usual Manner

activator and stop bath chemicals are dry-packed, sold in kit form, ready for mixing to make a gallon of each solution. The stripping solvent is sold by the quart. Hot water can be used to remove the film from the screen after use. Since the film is water soluble, however, water soluble pigments are not recommended.

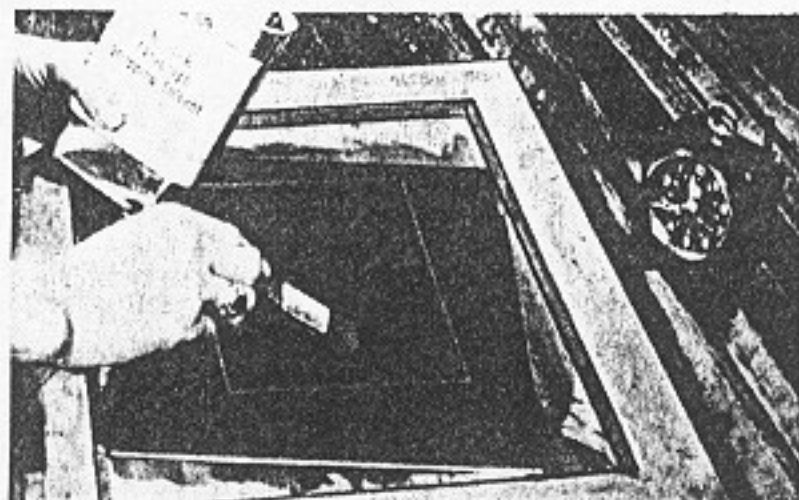


Fig. 153. Moisten Both Sides With Stripping Solvent

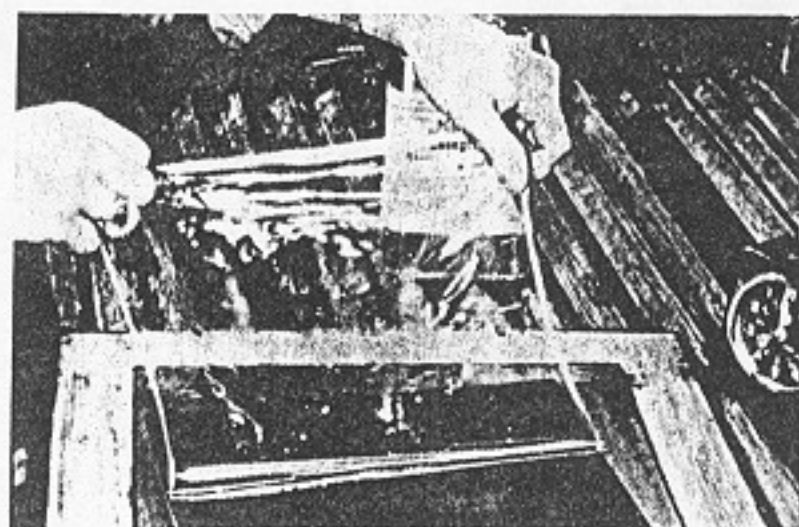


Fig. 154. Remove Back Sheet

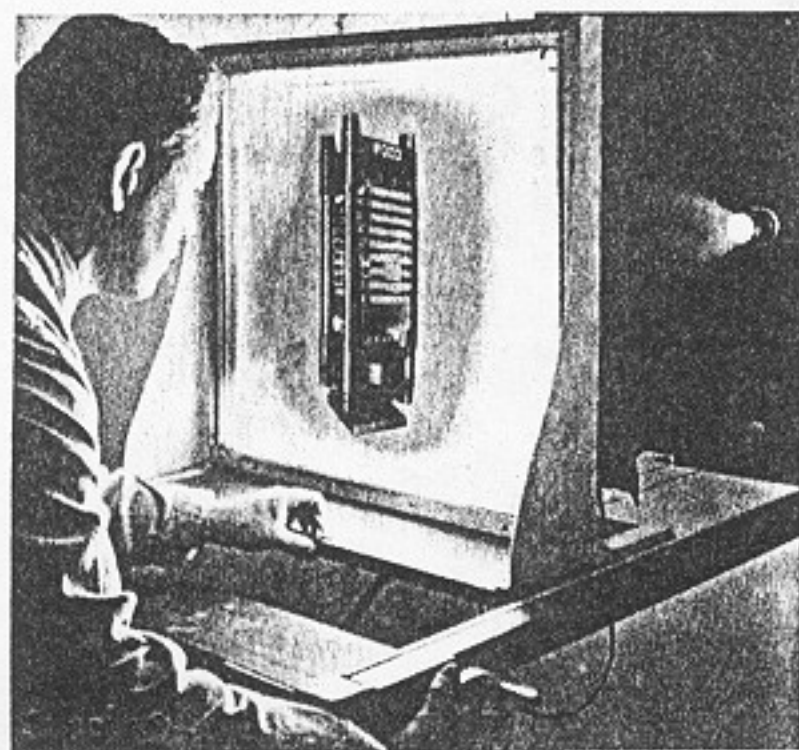


Fig. 155. Exposing With a Camera
Courtesy, E. I. du Pont de Nemours & Co.

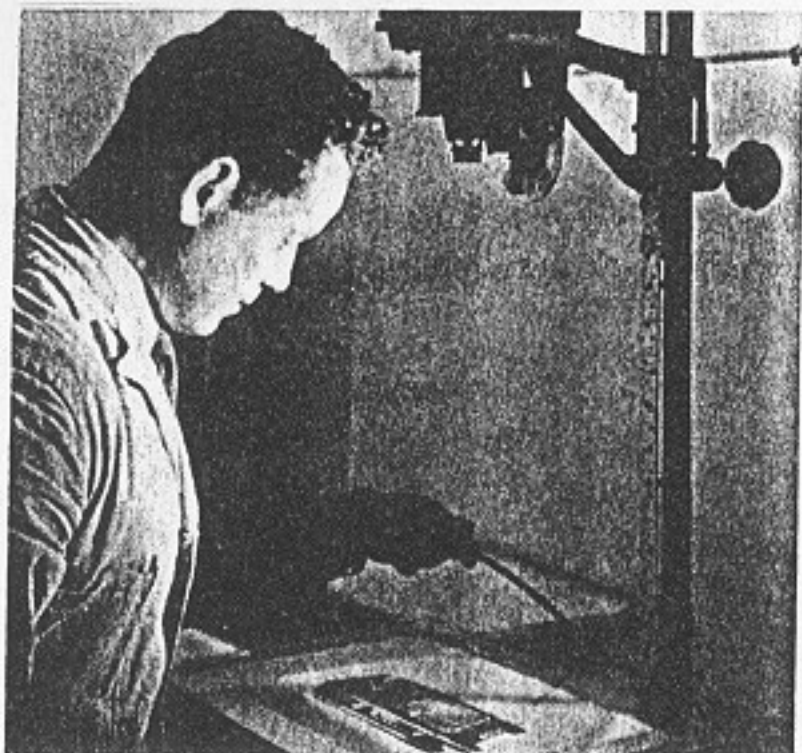


Fig. 156. Exposing With an Enlarger
Courtesy, E. I. du Pont de Nemours & Co.

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DuPont Screen Process Film. This film is slightly different in nature but is also a pre-sensitized film. It does not carry its own developer so that it must be developed in two separate developing baths for one minute each. This film must be handled in a dark room under safelight conditions, but has a very unusual advantage in that it can be exposed in a camera, Fig. 155, or by projection with an enlarger, Fig. 156, as well as by contact. It is an extremely sensitive film and exposure times are very short. One further advantage of this film is that after development it can be dried and then stored or shipped, prior to re-moistening it and applying it to a screen.

The instructions of each manufacturer should be followed strictly when using any indirect photographic film. They are simple to use, save countless hours of hand cutting and produce fine, professional results.

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Chapter 11

Direct Photographic Method

The direct photographic method of stencil making differs from the indirect only in that the gelatin material is applied directly to the screen fabric, eliminating the transfer of the film to the fabric. Usually this gelatin material contains the sensitizer as well, so



Fig. 157. Ingredients of Emulsion

that when it is applied to the screen and allowed to dry, the entire screen is sensitized. The greatest advantage in this method is the elimination of the process of sensitizing the film and allowing it to dry, and then transferring it to the screen after exposure. There is also the advantage of not having to block out marginal areas because the gelatin emulsion covers the entire screen opening. However, one definite disadvantage to this method is that the entire screen has to be cleaned free of gelatin and re-treated if an error is made or faulty exposure and wash-out is produced.

There are numerous commercial preparations available for the direct photographic method. All of them include an emulsion, either in liquid form or in powdered form. Water is added to the powder and the mixture is heated and dissolved. Some preparations contain the sensitizer and others do not. If the emulsion does not contain the sensitizer, then only one step is actually eliminated, compared to the indirect photographic method, because the gelatin will have to be sensitized after it has dried on the screen.

Most of the commercially-prepared emulsions contain pure animal gelatin, a photographically unstable chemical such as potassium bichromate or ammonium bichromate, glycerine to give flexibility and distilled water as the vehicle, Fig. 157.

Both bichromates mentioned are affected by a strong light; that is, if a strong light is allowed to fall upon them, they become extremely hard. If light does *not* fall upon them they remain relatively soluble in water. Basically, this is the secret of the direct photographic method.

NOTE: This is also the basis for the indirect method when a pre-sensitized film is not used. The sensitizer is usually a solution of either potassium or ammonium bichromate.

When the screen containing the emulsion is exposed to light (or in the case of the indirect method, the film which has been sensitized is exposed to light) those areas which have not received the light because they were covered with blocked out design areas, remain relatively soluble in water. The areas which received the full intensity of the light have hardened. Thus, when washed out with warm water, the soluble areas wash out clean while the hardened areas remain fixed and in place. After drying the screen is then ready for printing.

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The home or school craftsman may desire to prepare his own emulsion. This can be done simply, by using the following formula:

50 cc.	or	2 oz.	Cold water (distilled water preferred)
7.5 gr.	or	$\frac{1}{4}$ oz.	Gelatin (the commercial cooking variety)
50 to 75 drops			Glycerine (more in cold weather, less in warm weather)
1 tablespoon			Potassium bichromate, concentrated solution*

* A concentrated solution can be approximated in this instance by mixing the potassium bichromate in water at room temperature until no more can be dissolved without settling at the bottom. If larger quantities are used one pound of the chemical may be added to one gallon of water.

Directions for Mixing

Weigh out the powdered gelatin and place it in a small sauce pan. Measure out the water and add it to the gelatin in the pan. Allow the gelatin to completely slake in the water until it is quite hard and pasty. Add the glycerine. Place mixture in a double boiler and heat until completely liquified. In a semi-darkened room (no direct light) add the potassium bichromate solution. *From this point on, handle the solution, whether in storage, ready for use, on the screen, etc., in subdued light, until the actual exposure of the screen is accomplished.*

To Coat the Screen

While the emulsion is still hot, coat the silk (or other fabric) on both sides using a wide, soft brush, stroking first horizontally and then vertically. Be sure that no pools of



Fig. 158. Coat Silk on Both Sides
Courtesy, Leeds Sweete Products, Inc.

liquid form on the screen, Fig. 158. Dry the entire screen in a darkened area. An electric fan may be used to hasten drying as illustrated in Fig. 137. Do not become alarmed, especially when using silk or cotton organdy fabric, if the fabric loosens and sags on the frame after it has been coated. During the drying process it will tighten up again.

Exposure

When the screen has thoroughly dried, check it (in subdued light) for possible pin holes or small open areas. If these do not fall within the area where the design will be exposed, fill them in with any filler material. If they appear within the design area they will have to be re-coated with emulsion and allowed to dry. Pin holes are usually caused by *too brisk an application* of the brush, resulting in air bubbles in the emulsion, or, by *too hard an emulsion* in cold weather. This latter can be remedied by using more glycerine in the solution or by adding a small quantity of liquid animal glue to the solution while cooking it.

Turn the screen face up (fabric side up) and place a large book or a series of thicknesses of wood under the screen but within the open area so that these "props" serve to support the sensitized fabric when pressure is placed upon it, Fig. 159. Place the negative, properly centered, *face down*, on the sensitized surface. Place a sheet of clear glass on top of the negative to hold it tightly against the screen. Expose the screen for

4 minutes with a No. 2 photoflood lamp at a distance of two feet, Fig. 141. Use a watch to measure the exposure. After this operation the work may be continued in normal room light.

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Washing Out

After proper exposure, run hot water, (approximately 100°F.) over the entire screen with a spray head until the image washes out completely. The areas which were painted over on the negative, and which subsequently withheld the light during exposure are the areas which should wash out.

To test the washing out blow against the washed out areas. They should be thoroughly clear and free of emulsion. Dry the screen thoroughly with squares of newspaper as shown in Fig. 145.

Negatives for use with this process may be prepared in the same manner as those described in Chapter 10 and Chapter 12.

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Aqua Magic

This is the trade name for a new silk screen kit which is now marketed through art supply stores and which utilizes the direct photographic technique, Fig. 160. The

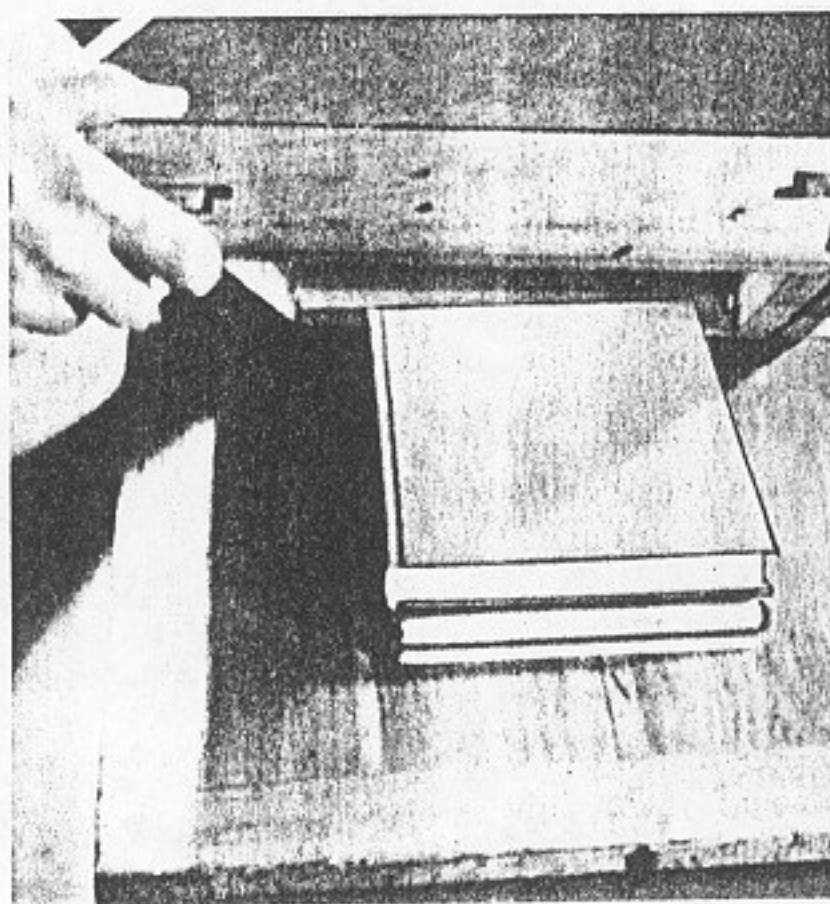


Fig. 159. Set-Up for Exposure

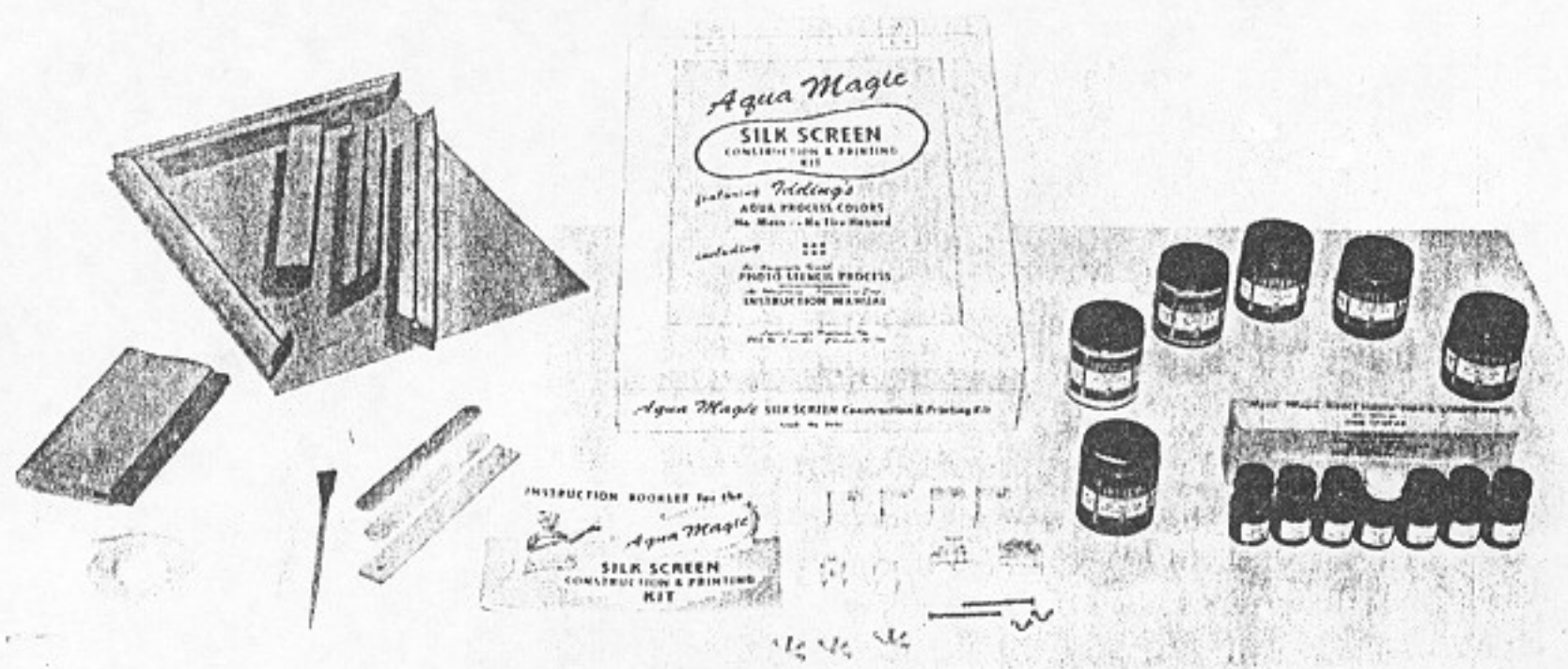


Fig. 160. Direct Photographic Screen Kit
Courtesy, Leeds Sweete Products, Inc.

kit comes complete with all component parts for constructing the frame and base board, stretching with silk, and sensitizing the silk. The kit contains the sensitizing chemical or emulsion in powder form, to which is added hot water. The set also includes a squeegee, a set of water soluble paints, and a special cleaner for removing the emulsion after the printing has been finished.

Normally, water soluble paints cannot be used with either direct or indirect photographic stencils because the substances from which they are prepared are themselves soluble in water. The great advantage of the *Aqua Magic* material is that it can be used with water soluble paints. This is a great step forward, particularly for home and school craftsmen.

In addition to preparing negatives for use with photographic screening, on transparent sheets, various opaque objects may be placed directly on the sensitized screen and then exposed to light in the usual manner, Fig. 161. In this manner silhouette areas are obtained. A few words of caution here: If at all possible, it is advisable to place a clear sheet of glass on top of the articles to keep them in close contact with the sensitized screen. The light must also fall in such a direction that shadows are not produced. These shadows would actually represent non-lighted areas, and these too, would wash out when the screen was developed in the hot water.

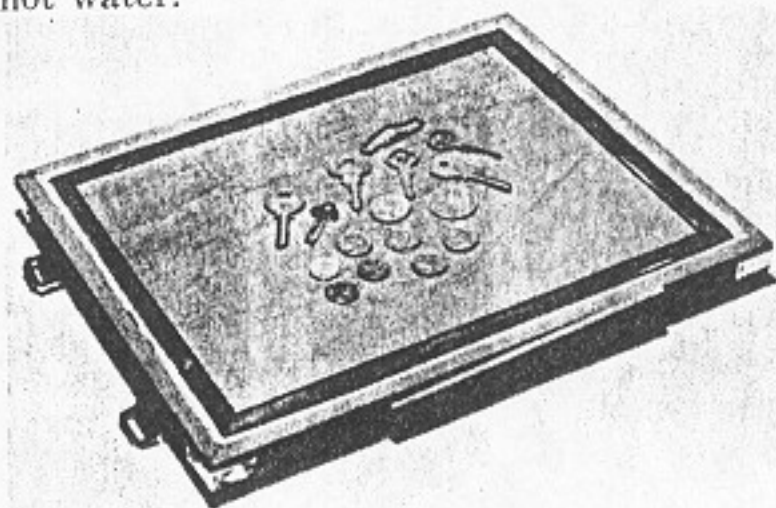


Fig. 161. Set-Up for Silhouette Exposure
Courtesy, Leeds Sweete Products, Inc.

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Chapter 12

Art Work and Lettering

It is not necessary to be an artist or

possess special art talent to do silk screen work. A great many of the jobs merely call for reproduction of a simple sign, poster or design. There are occasions, though, when it will be necessary to do artwork, even though the pictorial work or lettering may be adapted from other sources.

Artwork Aids

By keeping a clipping file, one who does not possess the ability to draw well will soon have a file of illustrative material that will

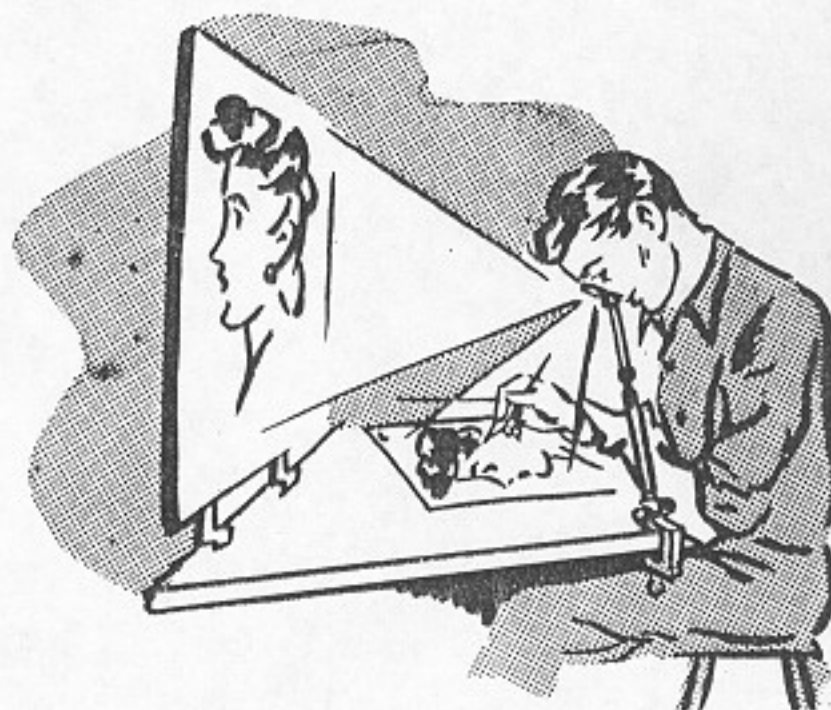


Fig. 162. Camera Lucida

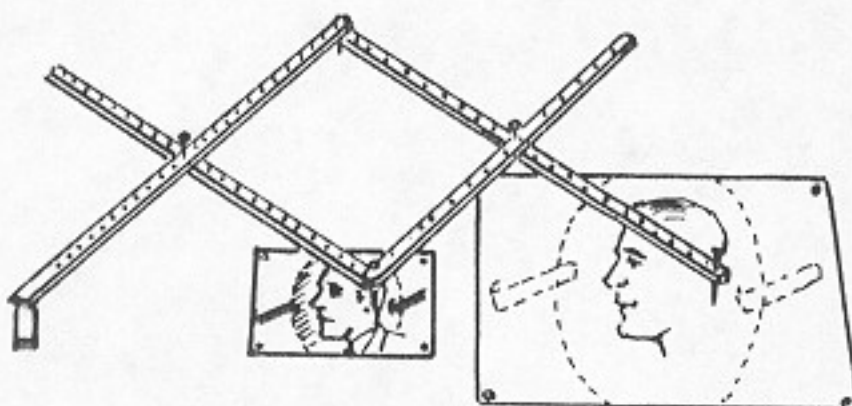


Fig. 163. Pantograph

meet the requirements of any job. Watch newspaper and magazine ads for items that can be adapted to silk screen techniques. Direct mail circulars are another good source of ideas. If the copy is not the correct size for the poster to be made, it can be enlarged or reduced easily.

The camera lucida, Fig. 162, is a device for enlarging, reducing, duplicating or reversing sketches, drawings, letterings, portraits, etc. The object to be drawn is reflected to the drawing surface in full detail and in true perspective. In Fig. 162, the copy is

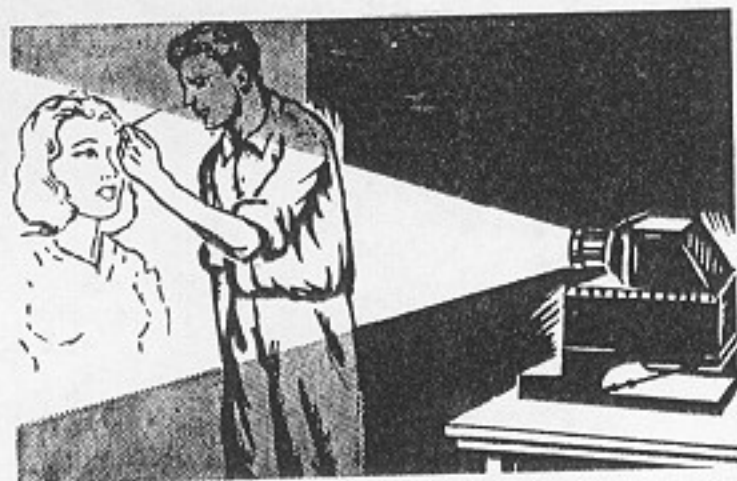


Fig. 164. Opaque Projector

attached to the back of the drawing board and appears on the drawing sheet in reduced form.

The pantograph, an inexpensive type of which is shown in Fig. 163, is a device for enlarging. The ratio of enlargement is established by setting the position at which the two arms cross. The pointer at the apex of the triangle is guided around the original. At the same time a pencil attached to the

end of one of the arms duplicates the outline in a larger size. More expensive types of pantographs are also available. These have greater precision and will *reduce* as well as *enlarge* the subject matter.

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The opaque projector, one model of which is shown in Fig. 164, projects an enlargement on a wall or any drawing surface. The size of the enlargement is determined by the distance from the projector to the screen. They will project colors and black and white.

There are numerous sources for alphabets of various styles. A printer's specimen book will show a variety of faces and sizes of type. Fig. 165 shows a method of evolving Gothic alphabet styles often used for silk screen reproduction. The letters composed of straight sections such as E, F, H, etc., are easily made with a template and horizontal lines as those on a music scale. See Fig. 165 a, b, c. The letters which involve round sections may be made with a compass

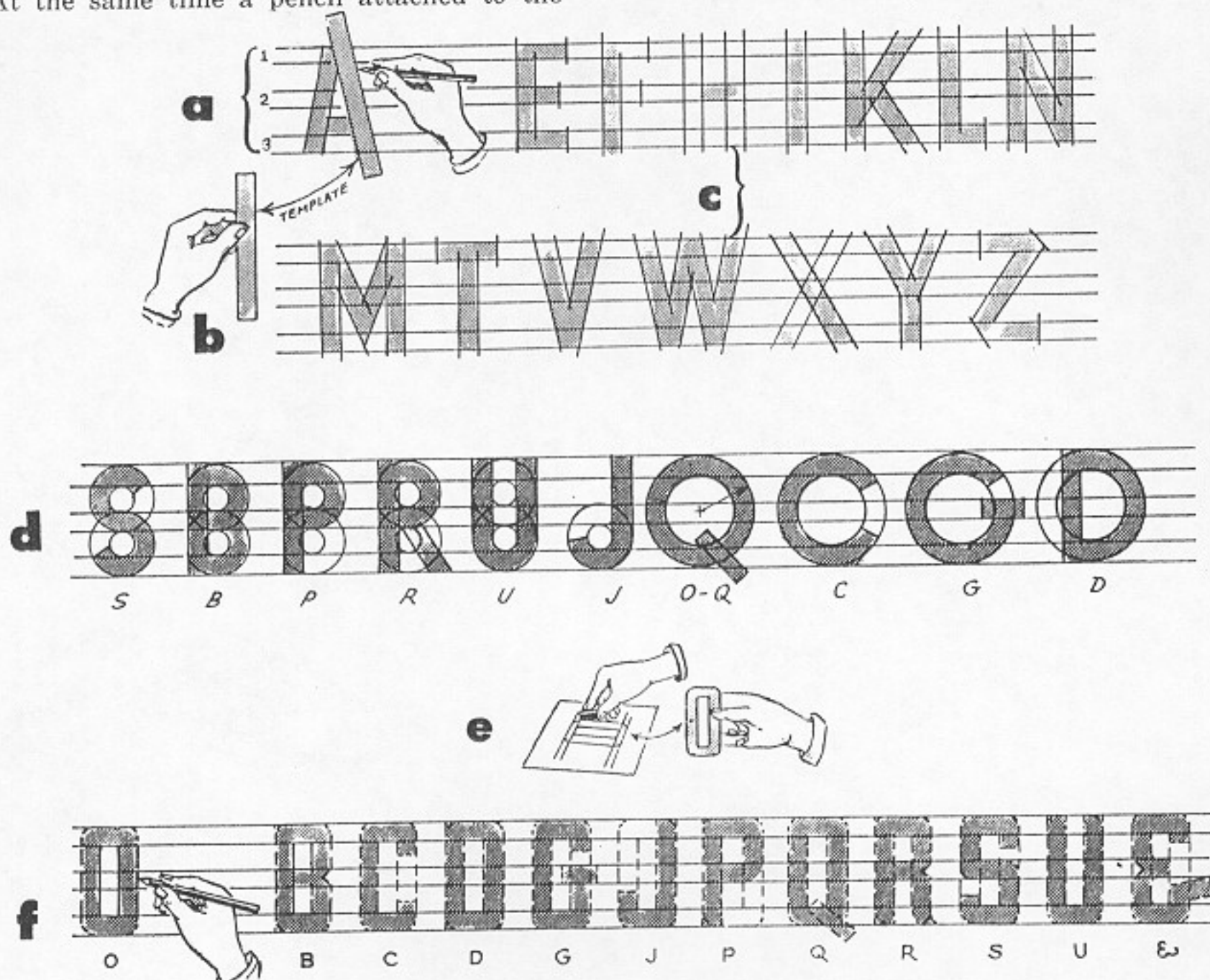


Fig. 165. Construction of Letters With Lines and Template

as in Fig. 165 d. Those with rounded corners as in Fig. 165 f, may be made using an "O" template cut from cardboard, Fig. 165 e.

Fototype is another source of letters. A font of Fototype is shown in Fig. 166. The letters are arranged in the composing stick. When the line is full, a piece of cellophane tape is applied to the individual pieces holding them in proper position. The lettering may be enlarged or reduced photographically, or just enlarged using the opaque projector.

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Fig. 166. Fototype

Selected Headings Fo

★ 503 Caps & Lower Case

Selected Head

★ 504 Caps & Lower Case

Selected H

505-L Lower Case

★ 505-C Caps

Selecte

507-L Lower Case

★ 507-C Caps

Selec

★ 508-L Lower Case

★ 508-C Caps

Sel

509 Caps

510 Lower Case

Fig. 167. Sheet Letters With Pressure-Sensitive Adhesive
Courtesy, Cello-Tak Lettering Corp.

Preparing Photographic Positives for Screening

Drawings, sketches, etc., can be treated in the manner illustrated in Figs. 162, 163, and 164, except that they have to be drawn with photographer's opaque or jet black drawing ink on a transparent base, as described in Chapter 10. There are special types of drawing inks made expressly for drawing on acetate. It will be recalled that a photographic positive is similar to any other positive picture (the black areas are black and the white areas are white) with the exception that the image is printed on a transparent material. Therefore, the white areas are actually clear and light will pass through them.

Additional Hints

The craftsman who lacks either the talent, or more usually the time, required for complicated lettering jobs now has available to him a countless array of all types of letters printed in jet black ink on a clear acetate base, with a pressure adhesive on the back, Fig. 167. These letters are merely cut out with a razor blade and mounted in the proper place on a sheet of clear acetate. Rubbing across the face of the letter with a burnisher (the end of a fountain pen serves very well)



Fig. 168. Burnishing Letters in Place

will adhere the letters in place, Fig. 168.

Various texturing materials are also available, Fig. 169, printed in like manner in jet black on a acetate base. Sections of this in the desired texture and shape are cut out

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with a razor blade and mounted in the proper place. Certain of the letters and textures are also available in white ink on a black base for preparing reverse-printing photographic positives.

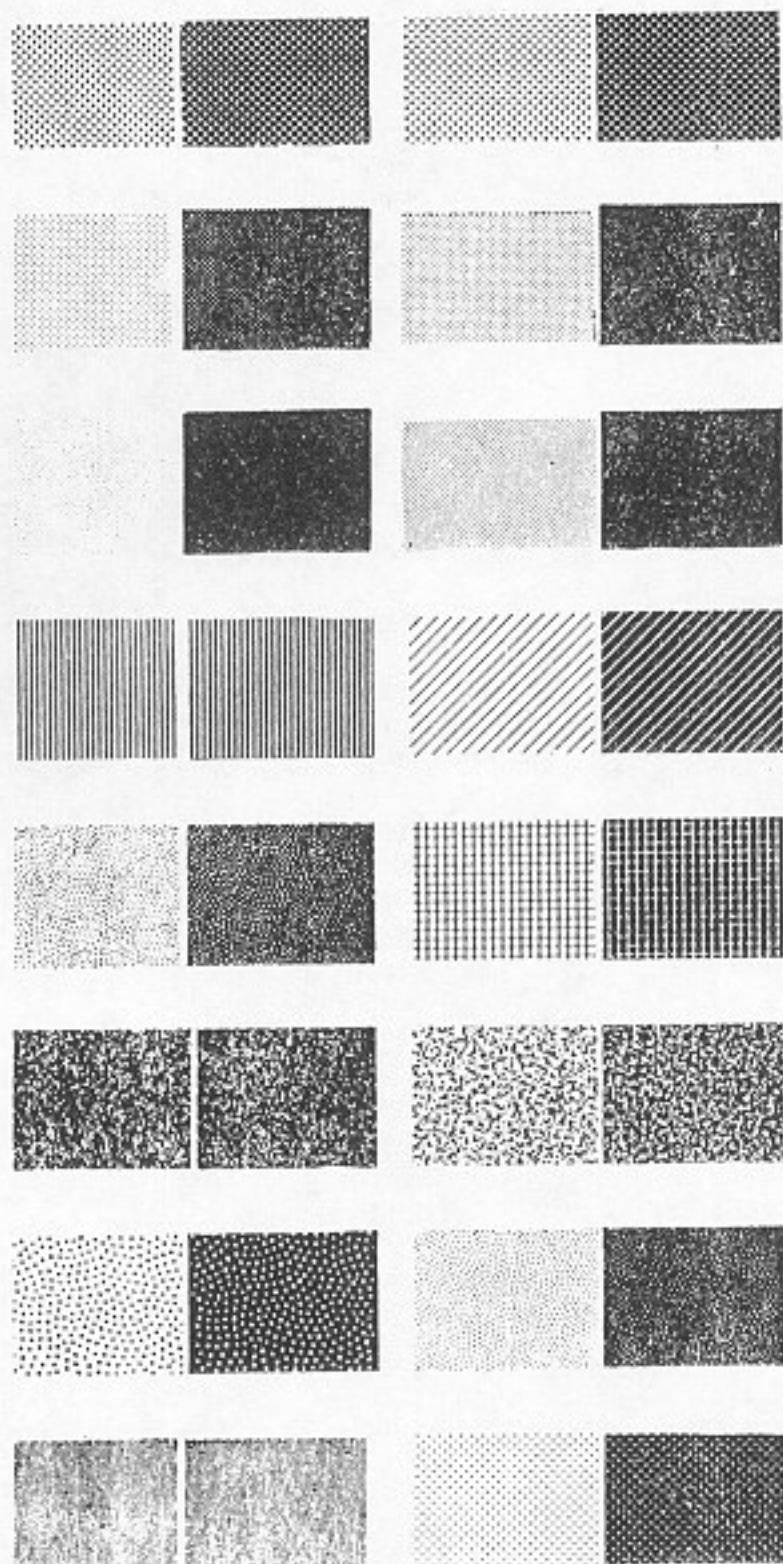


Fig. 169. Pressure-Sensitive Texturing Materials

Fig. 170 shows a squared Gothic alphabet in both capitals and lower case. Together with Figs. 171 and 172, the alphabets shown constitute good basic letter styles for the silk screen process.

Light tones shown in Fig. 173 may be

printed as a color tint (for example a light blue or light red) while the blacks shown may be printed in any dark tone of red, green, blue, etc. This is an excellent example, incidentally, of a screen job which can be done much more simply by one of the photographic processes. When the art work is complete the craftsman decides which technique will suit the job best.

To insure perfect silk screen reproduction, the original art work should be accurate and of the same size as the reproduction. For one-color work, a pencil sketch, carefully done, will usually be sufficient. For work in colors, it is best to make a copy in full color. It is possible to use a penciled outline with the color represented by bands or crosses in the respective areas.

For very complicated color jobs, sheets of various colors printed on pressure-adhering acetate base, as described above, are available. The shapes of each color desired are cut out and adhered in place. This saves long hours of filling in large areas with solid colors. If the lacquer film method is to be used for preparing the stencils, the *blue* film is made especially for use in color separation work.

For beginners, time spent in making a good original will usually result in a more professional job.

70



RSTUV

A

B

C

WXYZ



D

E

F

abcde f g

G

H

I

hijklmn

J

K

L

opqrstu

M

N

O

vwxyz \$

P

Q

R

¢ !

S

T

U

Fig. 170. Squared Gothic Alphabet

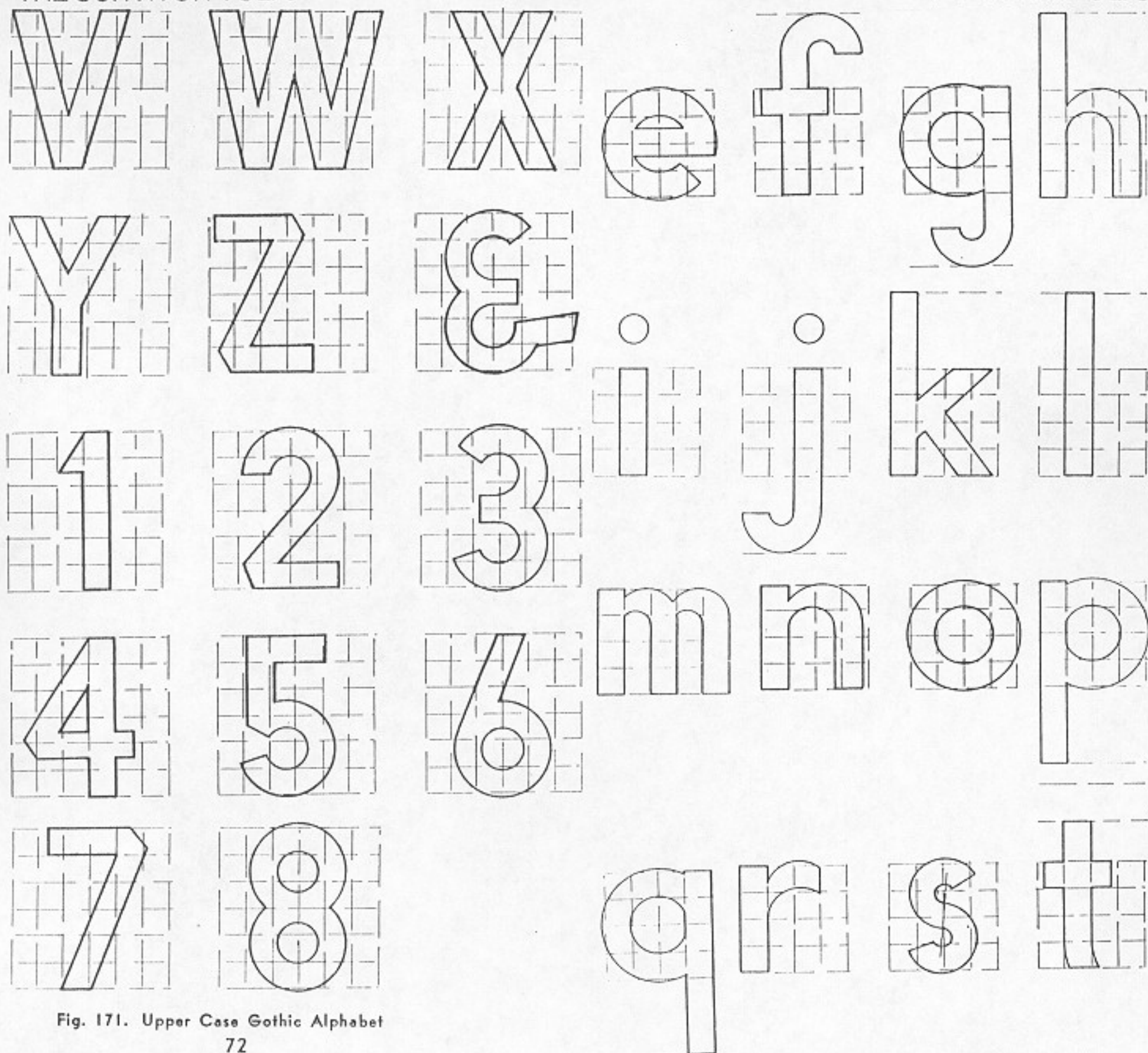


Fig. 171. Upper Case Gothic Alphabet

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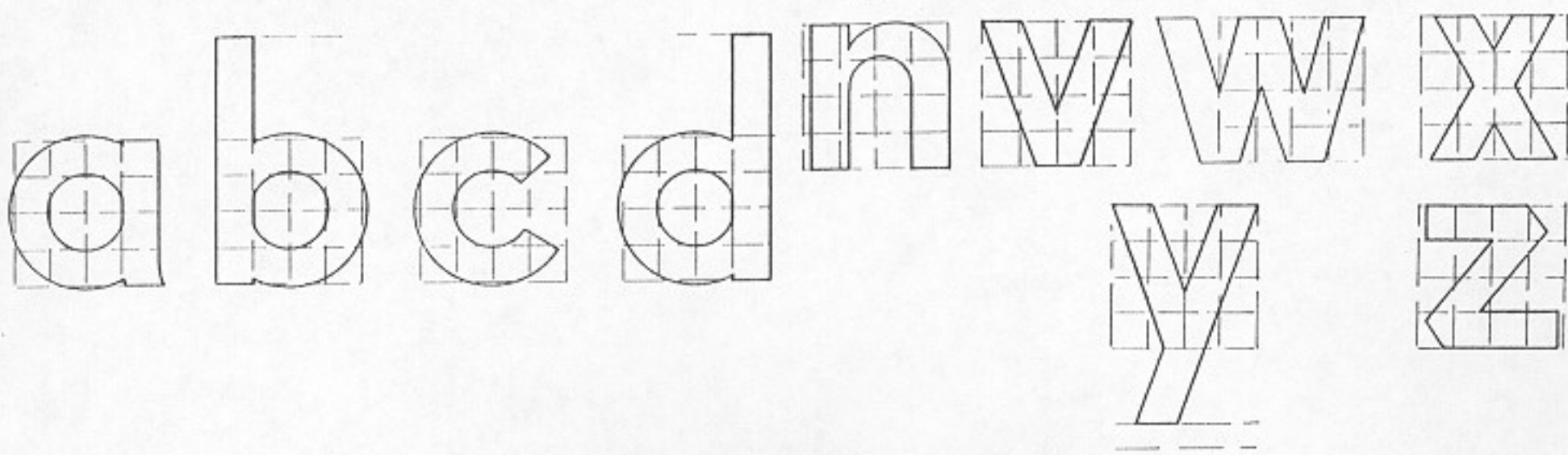


Fig. 172. Lower Case Gothic Alphabet



Fig. 173. Screen Job Simply Executed With Photographic Techniques

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Chapter 13

Multicolor Screening

Fig. 174 shows a poster head made in six tones. The original copy is shown in the upper right-hand corner. In making a poster head, a most practical method is to put the darkest tones in first, then the next darkest, etc. This insures a good likeness from the

beginning. If a likeness is not apparent after the second tone, the job can be started over without much time lost. This method is elastic, therefore economical, since it permits stopping after three or four tones have been used. See Figs. 178, 179.

Procedure

1. Coat the surface of the poster or illustration board with a light tone of show card paint, Fig. 175. Place the original copy in an opaque projector and pencil



Fig. 175. Tonal Areas Marked in Projected Image



Fig. 176. Darkest Tone Painted

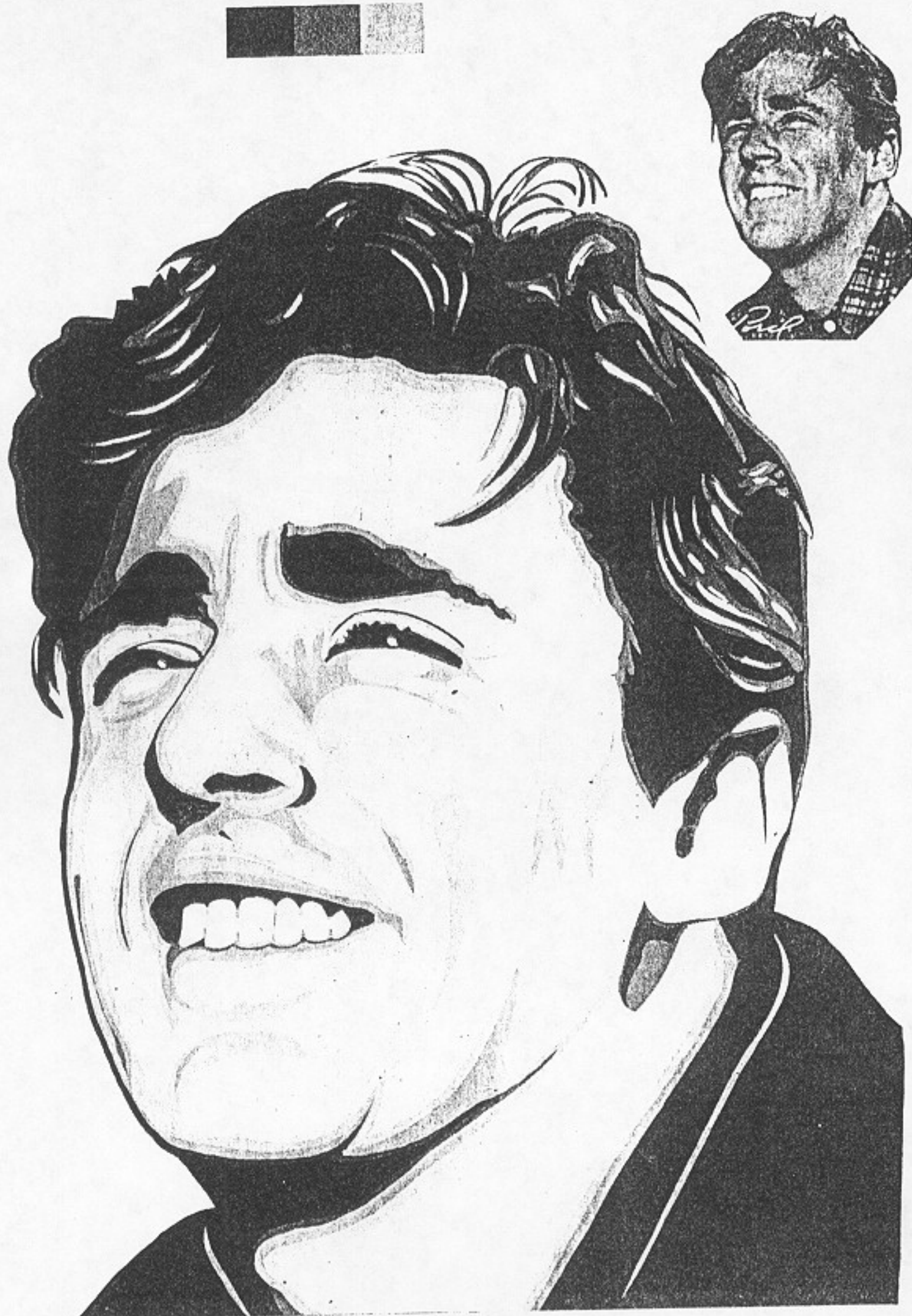


Fig. 174. Posterization of Head
Photo of Peter Lawford Courtesy of Metro-Goldwyn-Mayer
Posterization by Wm. Whitecar

the likeness on the coated surface. Mark the edges of the tone areas carefully.

2. Mix the tonal values or colors to be used. Note, in Fig. 174, the small "gray scale" at the top of the figure.
3. Select the darkest tone, black or blue-black, and paint in the darkest areas. These will usually be parts of the hair, eyes, nose, mouth, clothes, etc. This

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Fig. 177. Second Tone Creates Basic Likeness



Fig. 178. Third Shade Adds Tone Depth and Roundness

produces the *salient features*, making the head recognizable, Fig. 176.

4. Place the next darkest tone in the proper areas as shown by the pencil outline. The two tones should give a recognizable likeness of the subject, Fig. 177.
5. Place a still lighter tone alongside the second tone applied. This softens the



Fig. 179. Another Tone Establishes Facial Planes, Gives Third Dimension



Fig. 180. Fifth Tone Blends Highlighted Areas Smoothly Into Background

edges of the shadowed areas and gives the face greater tone depth and roundness, Fig. 178.

6. A fourth tone, still lighter in value, painted in adjacent to and slightly overlapping the third tone helps to establish the "face planes" giving the head a three-dimensional appearance, Fig. 179.

7. Mix the background tone with the fourth tone used. Use this mixture to paint

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around the edges of tone No. 4, helping to blend the various tones into the background. The background tones should show through as highlights, Fig. 180.

8. With this as the original art work, stencils may be film-cut for the five tones used. In running the tones, the lighter tones should be printed first, as in the reproduction of multi-colored pieces. The gray scale will, of course, not be included in the screening but will serve as a guide in matching tone values or colors needed.

Color Register

In multicolor screening great care must be given to proper register — the joining of each color with the last color. In the type of work discussed in this chapter successive colors are frequently "overlaid." That is, they are printed on top of a previous color. More usually than not, however, in multicolor work the colors must border evenly on each other. The following rules are important to remember:

1. As mentioned elsewhere in this book, where colors are to line up with each other, a slight overlap of about $\frac{1}{32}$ of an inch is desirable, provided the light colors are printed before the dark colors.
2. It is suggested that some kind of register device, or jig, be used when cutting the stencils. Such a device is illustrated in Fig. 125. If a separate screen frame is to be used for each color then they should all be of the same size and a corner mark should be placed directly on the silk with a soft pencil, Fig. 181, to guide the craftsman in adhering the stencils.
3. In cutting lacquer film stencils it is again recommended that the special blue film be used because colored art

work is viewed in more natural color with this than with the amber film.

4. A base board and a hinged screen should always be used. Register guides should be attached to the base board, Fig. 182,

so that each sheet is printed in precisely the same location. Care should be exercised that these guides are not moved when the screen frame is removed for cleaning and adhering of a new stencil for another color. By observing accurate cutting of the stencils in register, and by adhering them in register, and then by finally printing each successive

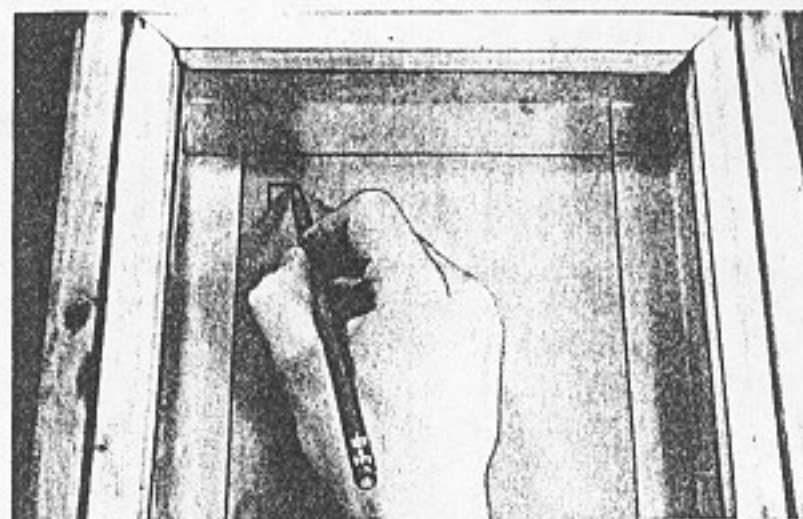


Fig. 181. Corner Mark Guide for Adhering Stencil

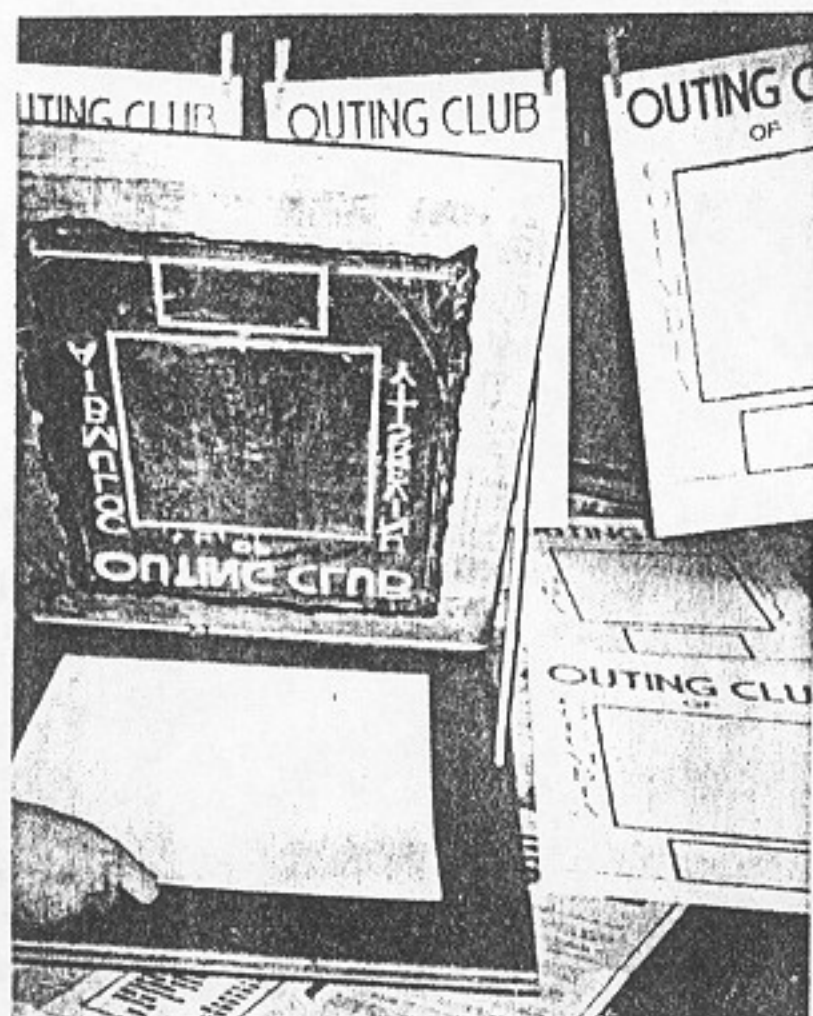


Fig. 182. Register Guides Attached to Base Board

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color in register using the guides on the base board, no difficulty should be encountered.

5. If the craftsman is working in very humid climates and if the job must be what printers call, "hairline register" — that is the colors must match in the borders to an absolute degree — then a plastic-backed lacquer film should be used.

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Chapter 14

Care and Cleaning of Equipment

Many instructions on cleaning equipment have been given throughout the text. However there are always additional items of information which the craftsman should know. A piece of equipment, no matter how inexpensive, will be completely worthless to the craftsman if it is not put away in condition for immediate use again.

Many of the pigments and other materials used in silk screen printing are manufactured so that they will air-dry to absolute bone-hardness. This means they will dry in a similar manner on the equipment too, and can never be removed. Many of the pigments are intended to be color fast when dry. They will be equally color fast on the finished product or on clothing if accidentally smudged.

Solvents

Many solvents and cleaning agents are used in cleaning silk screen printing equipment, Fig. 183. A *solvent* may also be called a *thinner* or a *dissolver*. It is a substance which will either dissolve a particular pigment or material, or which may be used to thin that same pigment or material. Thus, when water is added, in mixing a pudding, the water is said to be the *thinner*, or the *solvent*. Turpentine, when added to house paint, is said to be the *thinner*, or the *solvent* of the house paint. Many materials require different solvents to soften or dissolve them when they have become hard than they do when in soft or liquid state. For example, if we use water to remove a bit of pudding

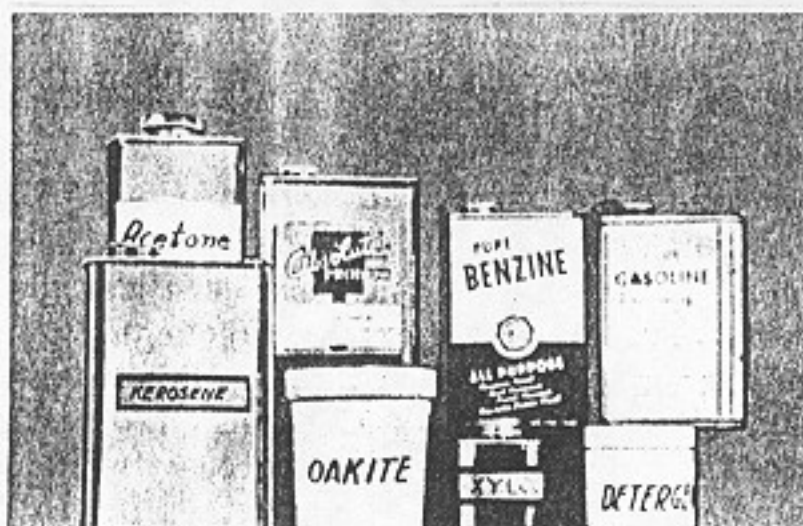


Fig. 183. Solvents and Cleaning Agents

which has dripped out of the bowl it will dissolve the pudding completely. After the pudding has hardened, however, it may take soap, scouring powder or other solvents to remove it. Turpentine, while it dissolves liquid paint will not dissolve paint which has hardened. This requires a different solvent.

Some of the techniques in silk screen printing depend upon the fact that *two* or *more* materials are used, *each* of which requires a *different solvent* to dissolve it. This is the essence of the various resist methods, such as tusche and glue (Chapter 7), reverse color method (Chapter 8) and so on. Thus, part of the work can be washed out, or dissolved, by using the correct solvent and the remainder of the work will remain unaffected by this solvent.

The following substances are the ones which have been generally discussed in this book. Next to each substance is listed the solvent. In cases where a different solvent is required for dissolving the substance *before* hardening than *after* hardening both solvents are listed.

Lacquer film and fill-in lacquer	Adhering liquid Washing thinner Lacquer thinner Acetone
	80
Water soluble filler	Water (Sometimes with soap or Oakite)
Shellac	Shellac thinner Wood alcohol
Tusche (in liquid form)	Water
Tusche (when	Kerosene

hardened)	Benzine Gasoline
Glue	Hot water
Water color paint	Water
Finger paint	Water
Silk screen poster colors	Kerosene
Textile paints	Kerosene (virtually irremovable from clothing)
Photographic films and gelatin emulsions	Special solvents <i>Oakite</i>

Remember that there is no *one* universal solvent.

Kerosene

Kerosene makes an excellent paint solvent for cleaning up. Remove the excess paint from the basin with a piece of cardboard. Save it, for it can be used on another job. Wipe the screen on both sides with a rag saturated with kerosene. This dissolves the paint quickly and one or two such wipings

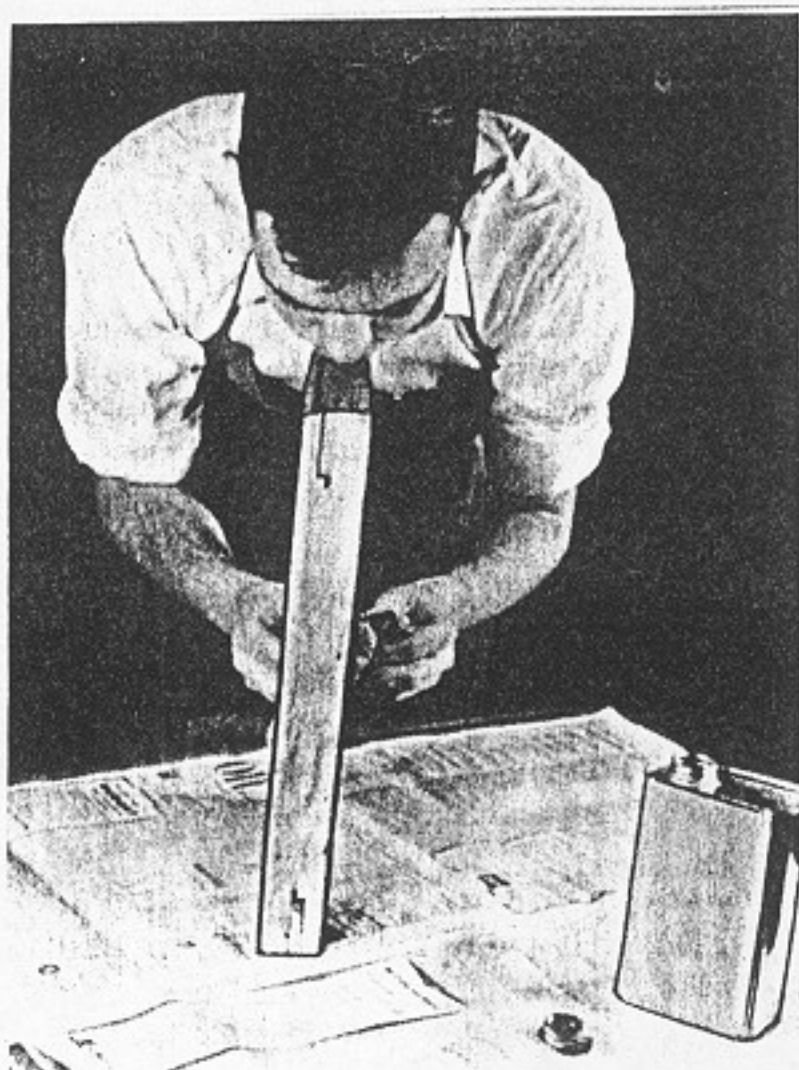


Fig. 184. Scrub Both Sides at Same Time

are usually sufficient to remove all of the paint.

Cleaning the Stretched Fabric

A final, thorough cleaning of the stretched fabric, whether the stencil has been left adhered for future use or not, frequently requires hard rubbing with a cloth. This operation always endangers the tension of the stretched fabric. Direct pressure, without a support behind the silk or other fabric, should never be applied.

An excellent technique for "scrubbing" the fabric is illustrated in Fig. 184. The operator holds a small piece of soft cloth, saturated with kerosene, in each hand. He uses his chin to hold the frame steady and vertical, and proceeds to rub both sides of the fabric *simultaneously*, exerting equal pressure from both sides. In this manner the pressure exerted is from one hand against the other and the fabric does not receive any strain. In using this technique, care must be taken not to scratch off any areas of the stencil, if the stencil is to be left adhered.

Removing Stubborn Spots

Sometimes when the stencil has been removed one small portion of it remains in place and refuses to dissolve. Also, some of the commercial textile paints have a tendency to develop stubborn spots. These can be removed, using great care, with a small hand brush moistened in the proper solvent

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and rubbed across the stubborn area, Fig. 185. When using metallic fabric much more vigorous scrubbing action may be applied.

Removing Photographic Materials

All gelatin materials dissolve in water

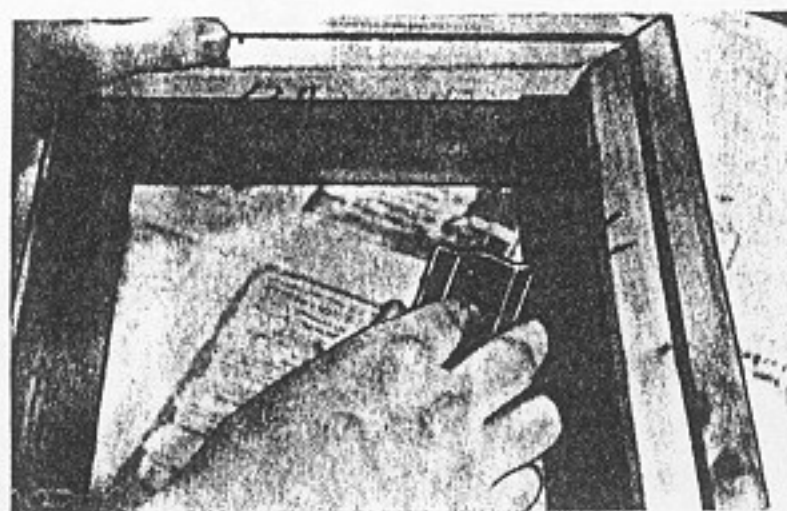


Fig. 185. Removing Stubborn Spot With Brush

but sometimes slowly. Regardless of the solvent used, whether a commercial preparation or not, it is advisable to soak the entire frame in hot water for about one hour before attempting to remove the stencil. It will be recalled that a water soluble filler was recommended for use with photographic screens instead of a lacquer filler, so that water could be used to clean the entire screen.

Squeegees

The squeegee should be cleaned with the proper solvent immediately after use. Thin deposits of paint allowed to harden on the squeegee are extremely difficult to remove without possible damage to the rubber blade.

Personal Cleanliness

A careless, sloppy craftsman leaves his mark on every job. Fingerprints, accidental smudges, accidental blending of colors — these are the marks of a poor craftsman. If it is necessary to do the final printing job alone, as it so frequently is, the craftsman should thoroughly clean his hands with solvent and soap and water after he has set up the unit for printing. Exercise care from that point on so that the hand which will touch each piece of work does not get paint on it.

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Chapter 15

The Silk Screen Industry

Up until the early 1920's silk screening was practiced in the United States in a somewhat informal manner and, more often than not, behind locked doors to carefully safeguard the secrets of the craft. Techniques were not generally well-known nor widespread. Sources of supply were not centralized. Undoubtedly the paper stencil method was originally used because this was really borrowed from the stencilling artists of bygone periods. Tusche and glue probably was developed by an enterprising craftsman with a knowledge of the properties of tusche borrowed from the lithography arts. Lacquer film, of course, was a later development following the discovery of lacquer itself.

Today the industry is a vast one with a



Fig. 186. Typical Small Owner-Operated Shop

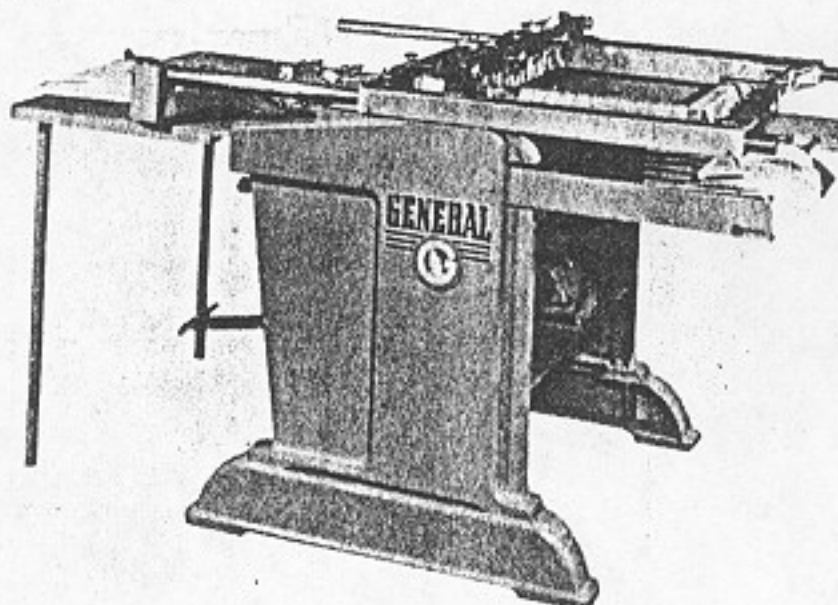


Fig. 187. An automatic screen printing press which is hand fed. The operator feeds in the sheets, as he would in a conventional printing press, while the lifting and lowering of the screen, and the action of the squeegee, are all automatic.
Courtesy, General Research & Supply Co.

tremendous literature, several periodicals (trade journals), numerous supply houses and countless specialized branches of the industry. It was inevitable that machinery would be invented which would mechanize many of the steps in the process. However, in common with certain other of the graphic arts, the original art work and preparation of the stencil is still largely a matter of individual handwork. The printing, feeding, drying, etc., have become mechanized. Items of machinery have been developed to assist the screen process worker in the practice of his trade.

The industry actually takes on several broad divisions. First, there is the part-time screen printer who usually has a small screening unit in his printing shop so that he can accommodate customers with small jobs. He may do all of the work himself or he may have the stencils prepared elsewhere, either photographically or by lacquer film

(hand cut). Then there is the small, owner-operated, but exclusively silk screening establishment. Fig. 186 shows such a shop. Usually run by one or two people, all of the work, from art originals to final product, is done within the shop. Of the large, exclusive establishments, there are basically two types. One prepares stencils and screens for the small printer, but does no other work

itself. The other variety is a large, completely-equipped screen printing plant. Frequently the larger establishments maintain complete art departments and do the printing in air conditioned shops.

The illustrations which follow depict the varied types of machinery in use today within the commercial silk screen industry. They show the highly specialized development of this industry at the present time.

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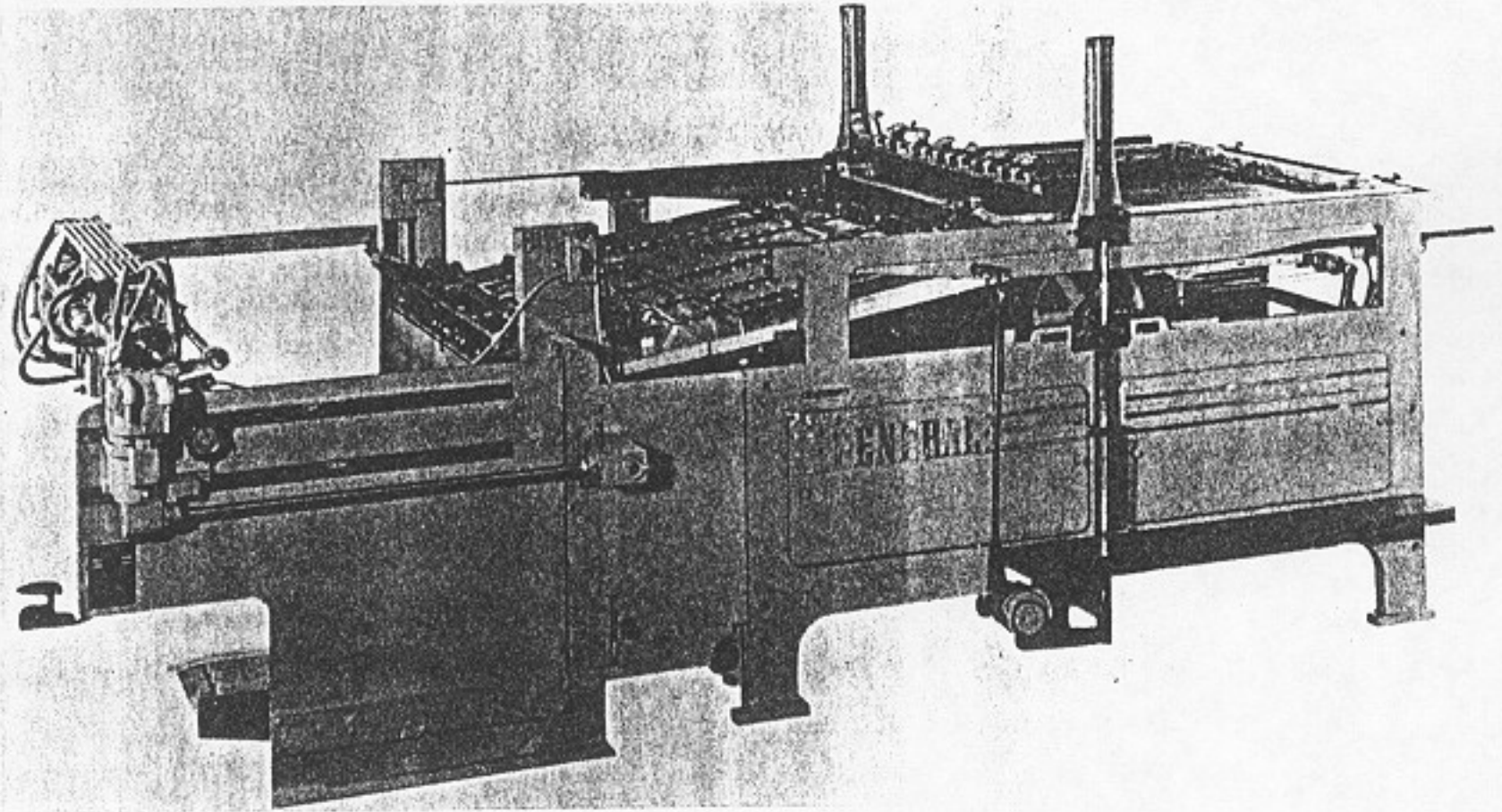


Fig. 188. An automatic printing press attached to an automatic feeder known as the "stream feeder." Similar to the pneumatic feeders used on printing presses, the

sheets are fed into the press one at a time, printed, and removed in rapid succession.
Courtesy, General Research & Supply Co.

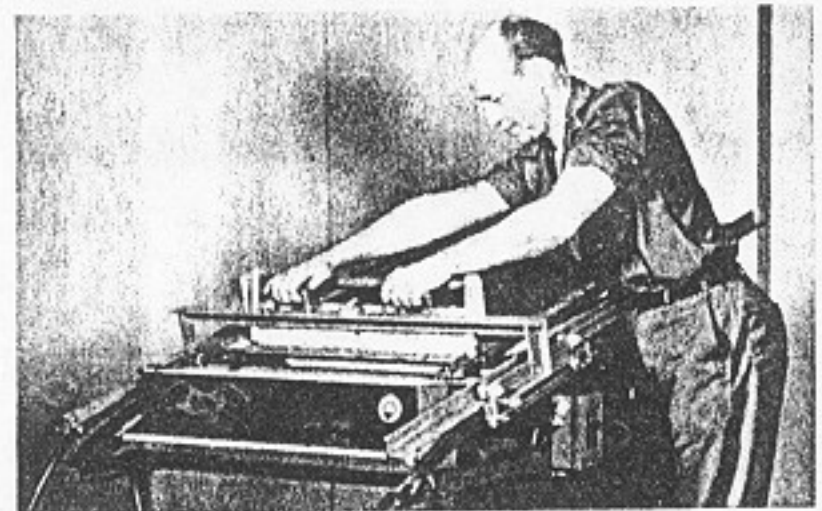
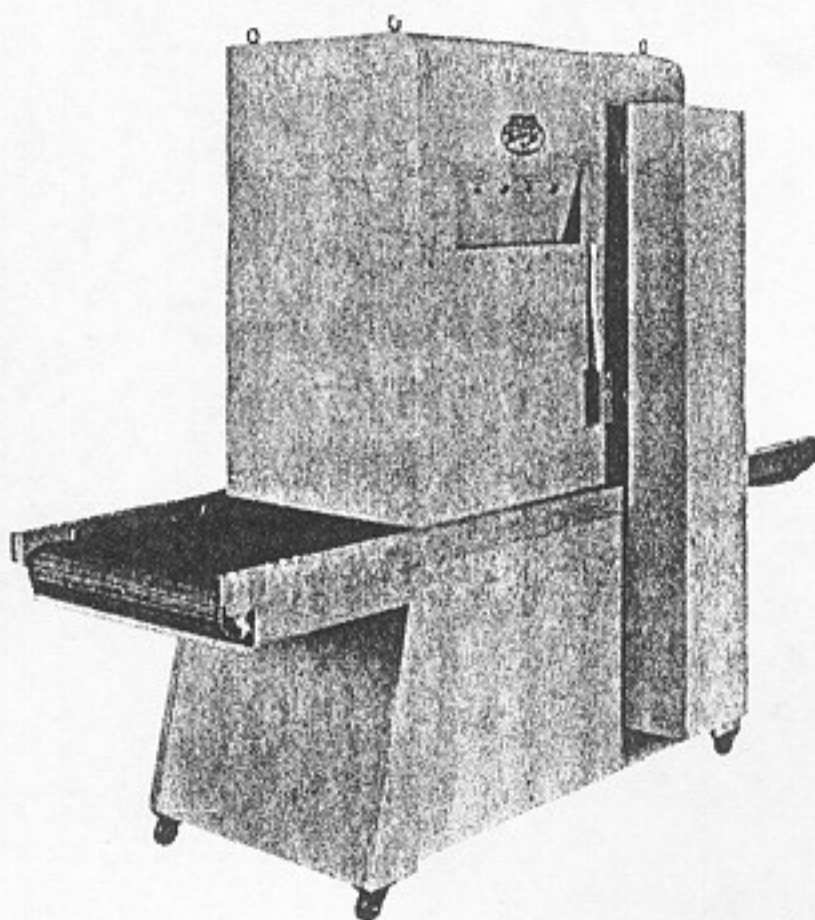


Fig. 190. This shows the new Dry Screen Process in operation. Drying of large pieces of stock has always been a problem in the silk screen industry. With this equipment the paint is applied through an electrically heated screen, resulting in a finished piece which is dry to touch as soon as it is taken out of the press.
Courtesy, Dry Screen Process, Inc.

Fig. 189. (Left) A drying machine known as the "Thermo-jet." A conveyor belt carries the printed sheet under the drying unit, retains it there long enough for drying and carries it out the other end.
Courtesy, General Research & Supply Co.

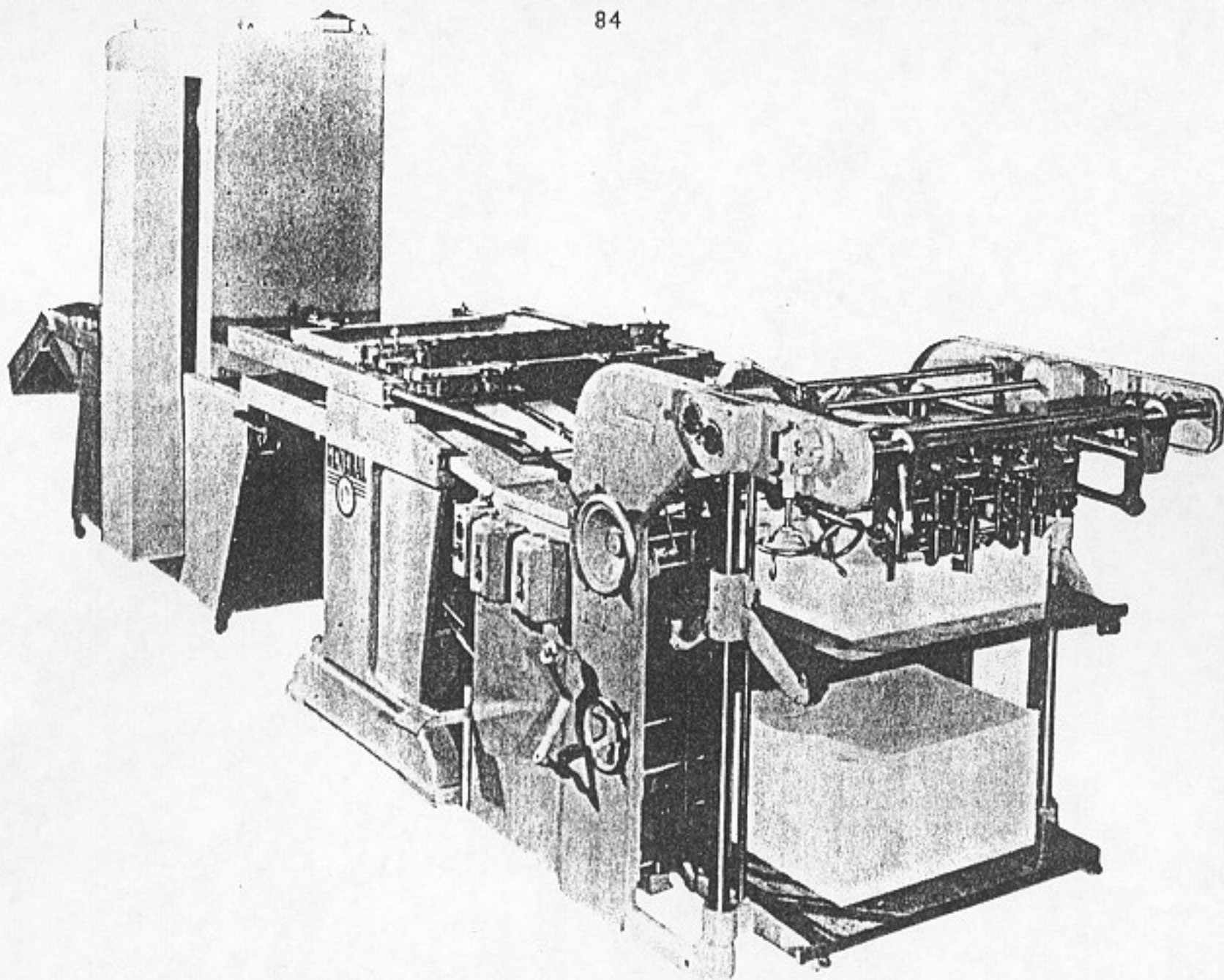


Fig. 191. This shows an automatic feeder, connected to an automatic printing press, in turn connected to a "Thermojet" dryer. The stock is handled automatically

from blank stock, through feeding, printing and drying, to the finished product.
 Courtesy, General Research & Supply Co.

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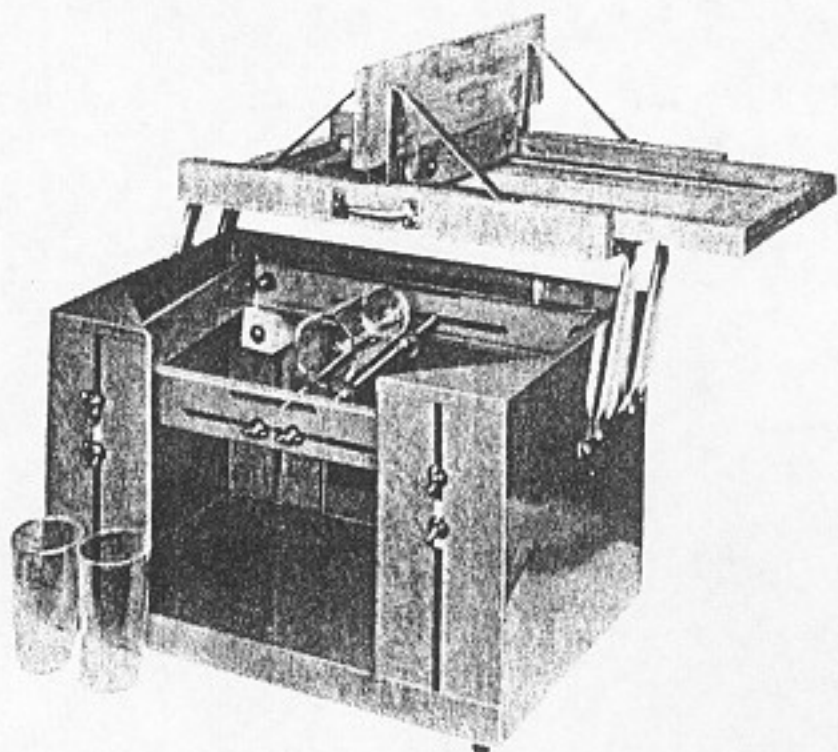


Fig. 192. A special jig press for printing other than flat objects. Glasses, tumblers, jars and bottles are printed in this manner.
 Courtesy, Atlas Silk Screen Supply Co.

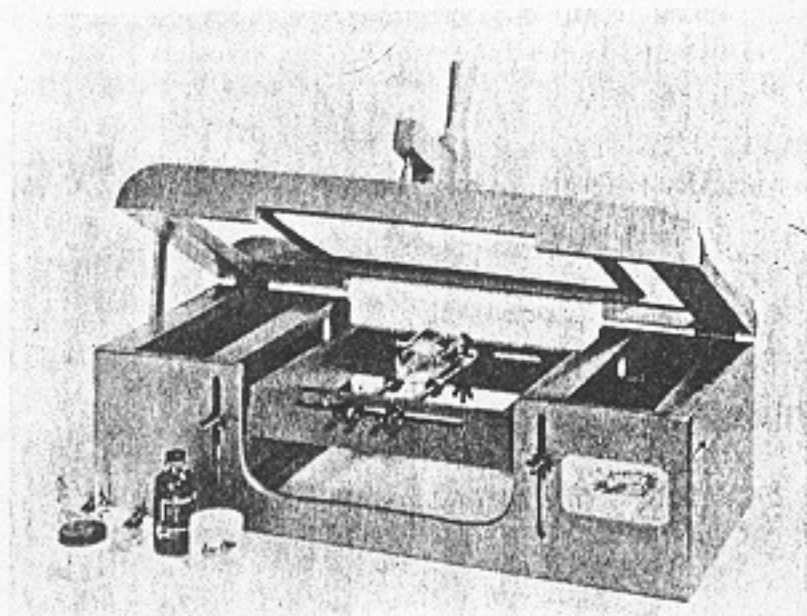


Fig. 193. A still larger variety of a jig press for printing on larger objects, such as barrels, drums, refuse cans, etc.
 Courtesy Photo Screen Process Mfg. Co.

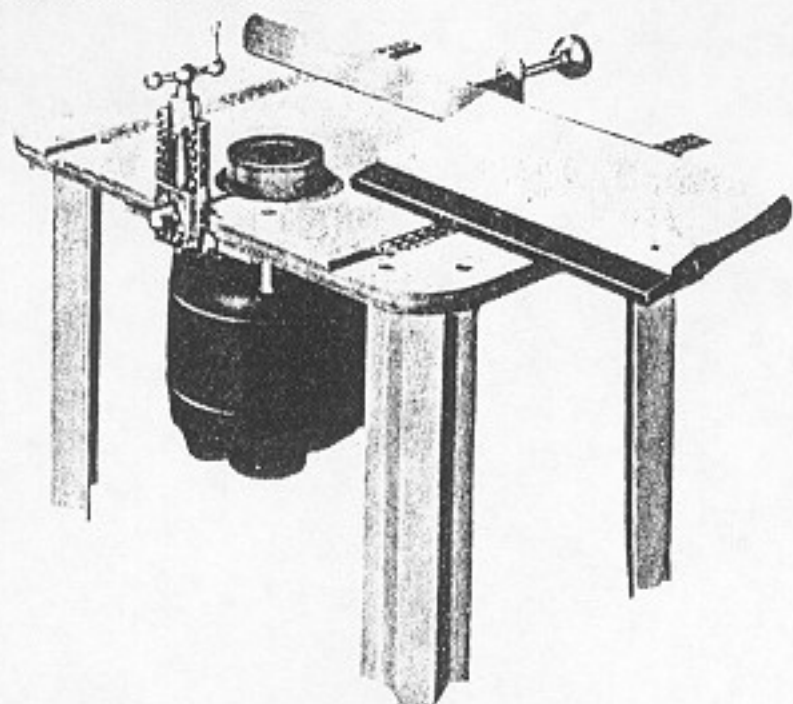


Fig. 194. So highly specialized has the industry become that this machine is used solely for sharpening the edges of rubber-bladed squeegees. In plants where hundreds of prints are produced each day, the problem of keeping keen edges on the squeegee blades becomes a serious one.

Courtesy, The Nat. Dar Co.

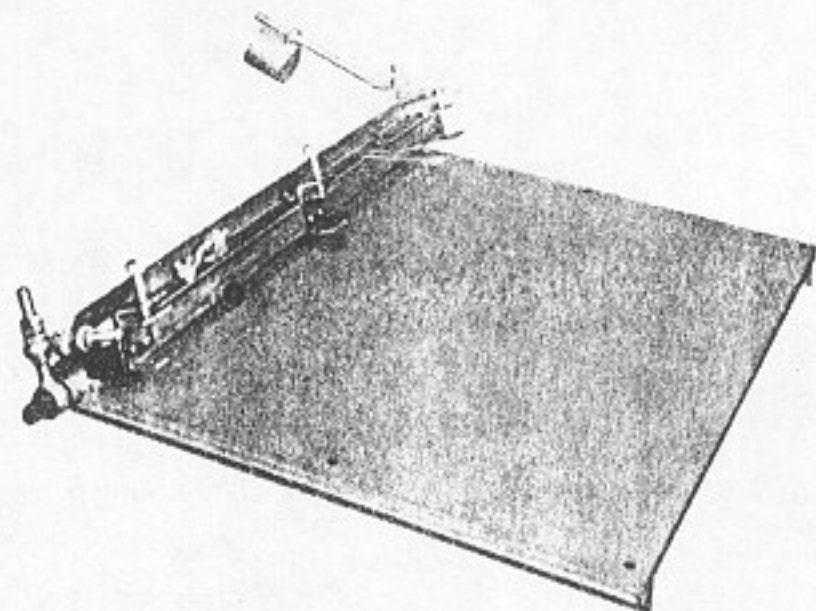


Fig. 195. An adjustable printing base with hinges, counterbalanced. This device, very popular in mass production plants, can be used with any prepared screen when attached permanently to a printing table. The screen is merely mounted in the adjustable hinging device at the back and the job is ready to be printed.

Courtesy, Atlas Silk Screen Supply Co.

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Chapter 16

Sources of Supply

Since sources of supply change so frequently and vary so greatly from geographical area to area, it is suggested that the home or school craftsman use his local classified telephone directory as a guide. The following headings in this directory will be helpful in locating a dealer:

Artists' Materials

Arts & Crafts Supplies
 Paint Manufacturers & Distributors
 Paint & Painters' Supplies-Dealers
 Paint & Varnish Removers-Dealers
 Paint & Varnish Removers-Manufacturers
 Photographic Equipment & Supplies-Retail
 Printing Inks
 Printing Supplies
 Signs-Equipment & Supplies
 Silk Screen Processing
 Silk Screen Processing Equipment & Supplies
 Stationers

Most manufacturers do not like to sell directly to the consumer because it violates agreements which they have entered into with their dealers and distributors. However, they will always furnish the name and address of a dealer in any given area.

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Chapter 17

Projects

This section will help the user of this book to refer to the various techniques discussed and suggests projects for the home and school shop which can be made using each technique.

Technique or method used	Suggested projects
The pocket sized screen (Chap. 1)	Monogrammed handkerchiefs Monogrammed shirt pockets Monogrammed noteheads or letterheads Monogrammed neckties
The paper stencil method (Chap. 6)	Greeting cards of all kinds Decorated paper napkins Decorated paper guest towels School posters Club posters
The tusche and glue method (Chap. 7)	Decorated scarves and kerchiefs Printed yard goods Drapery material Dress material
Reverse color resist (Chap. 8)	Posters Handbills Greeting cards
Lacquer film method (Chap. 9)	Printed aprons Printed nursery curtains Printed kitchen curtain material Printed bookbinding cloth
Photographic methods (Chap. 10, 11)	Boy and Girl Scout Neckerchiefs Club emblems Posters with great detail

Multicolor screening (Chap. 13)	School posters Program covers Athletic jackets Summer "T" shirts
---------------------------------------	---

Atractively decorated by screening:

Skirts	Pajamas
Table linen	Chair covers
Place mats	Tray cloths
Sunbonnets	Beach robes
Blouse cuffs and collars	Cloth belts
Summer pocketbooks	Pinafores
Hair ribbons	Gift ribbon

Gift wrapping paper	Bibs
Portfolio covers	Book covers
Desk blotters	Phone book covers
Shower curtains	Bathroom mats
Scrap book covers	Pennants
Canvas for lawn chairs	Curtain tie backs
Paper shopping bags	Potholders
Dresser scarves	Pillow cases
Bed spreads	Shoe bag
Laundry bag	Chair sets (head and arm pieces)
Doilies	Smocks
Knitting bag	White gloves

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ARC WELDING

In Twelve Practical Lessons

Foreword and Preliminary Instructions

By ARTHUR MADSON

Instructor, The Lincoln School of Welding
The Lincoln Electric Company, Cleveland, Ohio

Science and Mechanics Winter 1942

THE objective of these lessons is to present in a concise manner, certain fundamental facts of arc welding, the knowledge of which will enable the welder to use the welding process successfully and economically.

Welding, as ordinarily considered, may be defined as a method of joining metals by fusing the edges or surfaces, causing them to become molten, and thereby be fused together without pressure being applied. This is known as fusion welding.

In welding, use is made of an electrode held in a holder (Fig. 1) which is connected to one terminal of the generator.

The base metal or metal being welded is connected to the other terminal, or is laid on a table with a metal top which is connected with the other terminal. The terminal of the generator to which the electrode is connected depends upon the kind of electrode used.

The current-carrying electrode is touched to the base metal being welded, withdrawn and held so as to form and maintain an arc. A small pool, or a crater, is melted in the base metal. The electrode is also melted and deposited in the crater. The metal in the crater is agitated, mixing the molten electrode with the base metal and forming a dense joint. When the electrode is

THE many acknowledged advantages of arc welding in maintaining, repairing and constructing machinery, equipment, and products of many kinds, plus the urgent need for its widespread use in America's war production program, have prompted the editor of SCIENCE AND MECHANICS to present these twelve practical lessons for the benefit of many readers for whom a working knowledge of arc welding will be a valuable money-making asset.

In securing the cooperation of The Lincoln Electric Company, the editor has made available to readers the principles and material for welding instruction accumulated and applied in The Lincoln School of Welding which has been in continuous session since its establishment in 1917.

While the lessons in the series are built around the welding equipment and electrodes manufactured by Lincoln, the author points out that the principles can be applied to other makes and types of equipment provided they meet the specifications for the work which the lessons cover.

The author of these lessons, Mr. Arthur Madson, is and has been for many years the chief instructor in The Lincoln School of Welding, located at the plant of The Lincoln Electric Company, world's largest manufacturer of arc welding equipment, Cleveland, O. Mr. Madson is assisted in his work by four full-time instructors.

—THE EDITOR



ARTHUR MADSON

metal, the process is called the metallic arc process; when carbon, the carbon arc process.

Obviously, the metallic electrode furnishes additional metal to the base metal. But in the case of the carbon arc a filler rod may be used—the rod being fed into the arc and melted, fused, and mixed as outlined above for the metallic arc.

The details of these operations are given in the lessons that follow.

Welding current is obtained from special generators, the details of which are given in the lessons.

It is evident that the arc is very hot (temperature of approximately 10,000 degrees

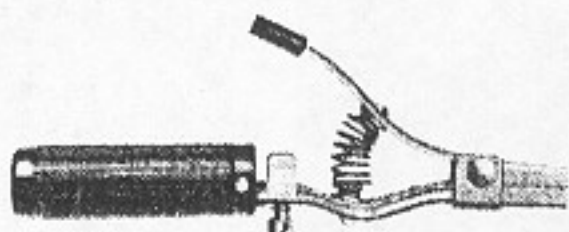
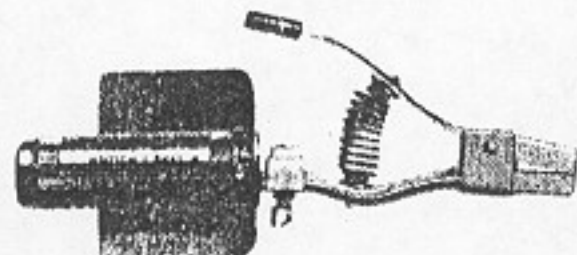


Fig. 1.

The electrode is held in a holder (unshielded or shielded handle) which is connected to one terminal of the generator.





Figs. 3 and 4. Special glass in a head shield (3) or a hand shield (4) provides eye protection from the intense glare of the welding operation.

F.) and therefore throws off both light and heat. It is necessary that proper protection be used. For eye protection a special glass in either a head (Fig. 3) or hand (Fig. 4) shield is used. It is essential that this glass be used at all times when looking AT THE ARC. As the special glass is expensive, it is protected by an ordinary clear glass.

Gloves (Fig. 5) preferably of gauntlet type, should be worn to protect the hands. A suitable leather apron is of great use in protecting the clothing, particularly when operator is sitting at his work.

It is also important that trousers without cuffs are worn and that legs of the trousers be held down over the shoe tops. Bicycle clips are excellent for this purpose. Leather spats or

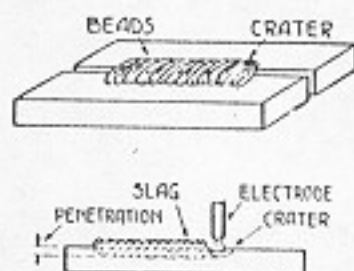


Fig. 2. A crater is melted in the base metal. The electrode also melts and is deposited in the crater.

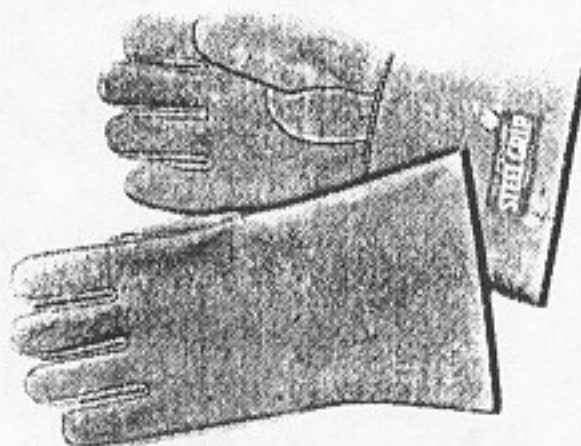
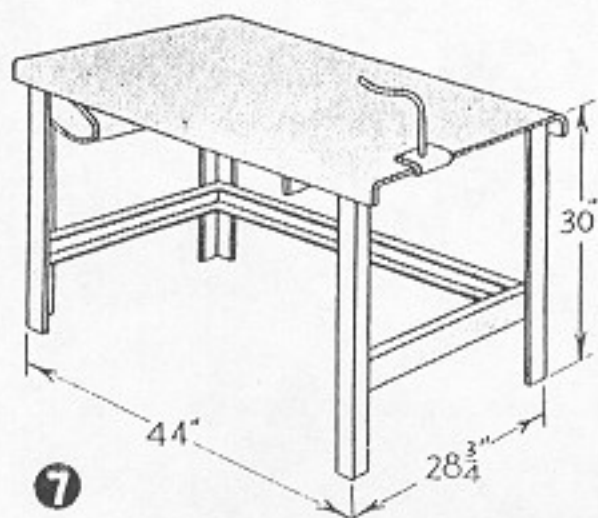
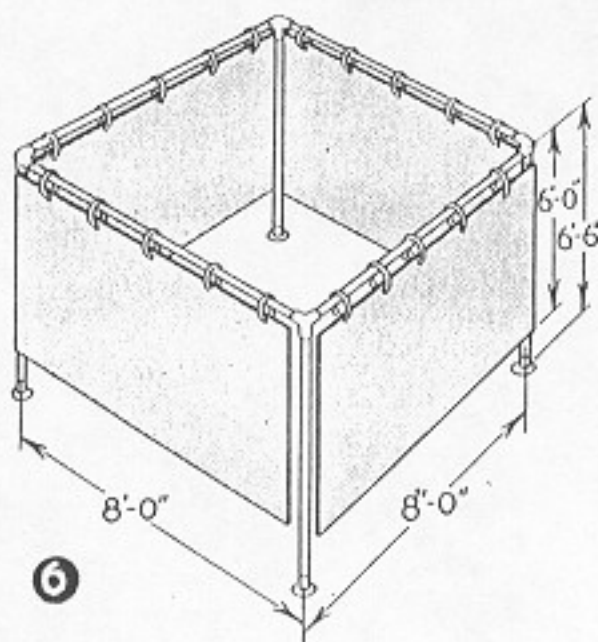


Fig. 5. Gloves preferably of the gauntlet type are worn to protect the hands from burns due to the intense heat and spatter of molten metal.



Figs. 6 and 7. A popular type of welding booth is shown in (6), and in (7) is sketched the metal topped table used in the booth.

leggings may be used. Otherwise there is a possibility of hot metal falling into the cuffs or shoes.

Where other work is done in the same shop, booths are necessary to protect the men from the arc rays. Figure 6 shows a popular type welding booth. The booth and walls of the shop which might reflect rays should be a dull black. Fireproofed canvas curtains on a pipe frame make a very acceptable booth, although asbestos curtain or sheet metal are much to be preferred.

Inside the booth should be a welding table.

Figure 7 shows one type. A metal top, properly supported at a correct height, with provisions for good connection of ground cable, is about all that is required. The operator can construct this of structural parts. An insulated hook, or something similar, should be provided for the electrode holder.

The next item is the electrode holder. This should be mechanically strong, light in weight, and be capable of holding the electrode firmly in position during welding, but allowing easy removal and replacement of electrode. It must not become too hot. The connection from electrode holder to machine is made by cable, which should be very flexible so as to offer a minimum of restraint to the operator's motions.

In addition to the equipment outlined above, the following should be available: steel scratch brush for cleaning welds, removing rust, etc.; tools for removing scale and slag from welds; carbon and copper blocks for backing up strips; and the usual shop equipment, such as vises, hammers, tongs, etc.

The arrangement of table and work should be such that operator may be comfortable. A strained, awkward position interferes with the doing of good work, whereas an easy, comfortable position is helpful and results in better production at lower costs.

SPECIAL INSTRUCTIONS. Do not play with the welding machine. Make a definite plan and follow it through. Learn the fundamental principles and wherever possible reduce your problems to those fundamental principles. You will find the solution of your problem much easier if you do.

Practice making samples and continue practicing and then do more practicing.

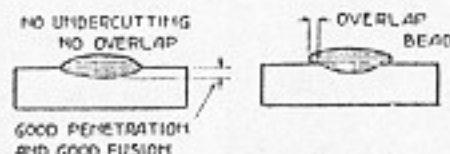


Fig. 8. A correct bead should have a good penetration, no overlap, and no undercutting. The strongest possible fusion must be obtained.

Open up the welds, examine them, criticize your work, ask criticism from others. Because you are melting a lot of metal is not a sign that you are welding.

Caution—Never look at the arc without using a protective glass to shield the eyes. Use a good high-grade welding lens in all cases.

Direct exposure or a "flash" will result in a very painful, but not permanent, burning of the eyes. If the eyes are exposed to the rays of the arc an application of cool boric acid is helpful or a few drops of 5% argyrol every four or five hours. Aspirin will relieve pain and headache and permit rest, which is very helpful in promoting quick recovery.

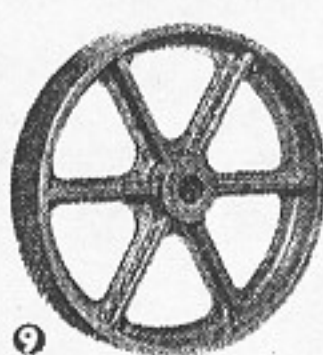
The position assumed at work has a great bearing on the kind of work done and the speed at which it is done. Therefore, be as comfortable as the job allows. It is easier on the operator and results in better work at lower cost.

It may be well at this point to explain, define, and illustrate certain terms customarily used by welders.

The bead is the metal deposited by the electrode (Fig. 2).

When the arc strikes the parent metal, metal is melted forming a pool or pocket. This is the crater. Its depth indicates the approximate amount of penetration.

A correct bead should have good penetration, no overlap or undercutting. Overlap is the amount of deposited metal "overlapping" but not fusing or melting into the parent metal. Undercutting is a melting of base metal along the edge



CASTING	
Weight	17.5 lbs.
Material	\$0.875
Labor	0.000
Total	\$0.875



STEEL	
Weight	12.5 lbs.
Material	\$0.33
Labor	0.21
Total	\$0.54
Saving, on casting	\$0.335



STEEL	
Weight	11.0 lbs.
Material	\$0.29
Labor	0.13
Total	\$0.42
Saving, on casting	\$0.455

of the weld which results in a depression. Figure 8 for explanation of these terms.

Often considerable ingenuity is needed on the part of production and maintenance men to overcome the handicaps of material and labor shortages. Arc welding makes it possible to fabricate virtually all types of machines and devices from materials readily obtainable, such as scrap pipe, for illustration.

An example of this is the case of wheels (Fig. 9) used on trucks and similar equipment for transporting materials within manufacturing plants. Although at first it might appear that a wheel would be a difficult piece to make, a closer scrutiny shows that the opposite is true and considerable sums may be saved by arc welding wheels.

It will be noted that the wheel shown in the center, fabricated by means of arc welding, was 38% less expensive than the one on the left, made by the previous method. This saving was due to reduction in the weight of material and the fact that the material used was less costly.

The arc welded wheel shown at the right in the illustration was still less expensive, because of simplification in design. This one saved 48% in cost over the previous type of wheel used, and 22% over the other arc welded design.

Wheels of this type may be made in almost any size and used in many applications.

Principles of Arc Welder Operation

LESSON 1

ARC welding, in principle, is similar to arc lighting. An arc lamp has two electrodes with their ends slightly separated. When a powerful electric current passes from one electrode to the other, it has to jump the opening, or "gap," between them. In doing so, the electricity generates intense heat between the tips of the electrodes. This terrific heat produces the brilliant light, or "arc," from which the arc lamp takes its name.

The arc for welding is produced the same way.

A powerful, though harmless, electric current is forced to jump a gap to complete its circuit. The gap is between the end of an electrode, to which the current is carried from the arc welding generator by a rubber-covered wire cable, and the metal being welded. As the electrical current jumps the gap, it generates such intense heat that it melts metal instantaneously. The temperature of the electric welding arc is 12 times hotter than a broiler! And that heat is something to be handled with care.

While the arc for an arc lamp and the arc for welding are the same in principle, there is one

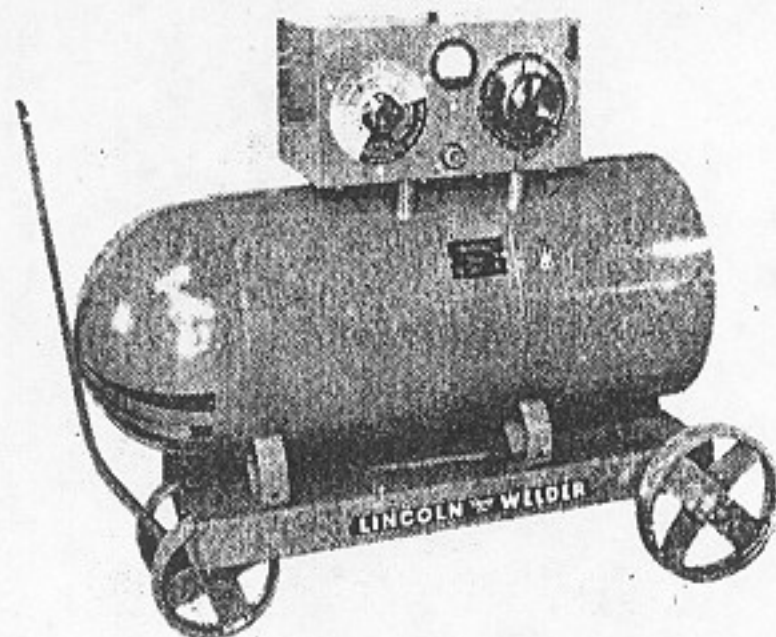


Fig. 1. Arc welder with self-indicating dual continuous control.

very important difference. In one instance, the arc heat produces *light*; in the other, it *melts steel*!

That's what takes place when a building, automobile, airplane, ship or other product is being built by welding. The welding electrode is held so that there is a gap between its tip and the metal which is being joined together. The heat of the welding arc produced by the electrical current crossing the gap melts the end of the wire, or electrode, and also melts the part or parts being welded at the point where the arc touches it. The molten metal from the tip of the electrode flows across the arc to the molten spot of the parts being welded. When the melted steel cools, the parts welded together—no matter how many there are in the particular structure!—become one, single piece. Not only is the welded structure one integral unit, but it is actually stronger in the welds than anywhere else!

The remarkable simplicity of arc welding—its ability to join metal directly together without intermediate connecting members and without the many extra operations of other industrial processes—this simplicity has permitted improved quality and

Fig. 3. Any desired volt-ampere curve may be obtained by varying the left-hand "job selector," to change open-circuit voltage.

Fig. 4. By varying the right-hand control, "the current control," the desired welding current is obtained.



Fig. 2. Special dials on the control box of the modern arc welder.

reduced cost of all sort of products and every type of structure.

Since it is important that the operator fully understand the arc welding machine before he uses it, this lesson is devoted to a discussion of the welder and the principles of its operation and use.

Material needed for this study includes: scrap steel, carbon holder, $\frac{1}{4}$ -inch or $\frac{3}{8}$ -inch carbons.

The Lincoln arc welder is an arc welding generator electrically separated from the drive and this drive has nothing to do with how the generator operates. It is not necessary to know all about the theory of the operation of the generator in order to operate it correctly, but it is necessary to know the various controls and just how these controls are manipulated so as to get the best results.

The welder (Fig. 1) is equipped with dual continuous control and has special dials (Fig. 2) which make the proper setting practically automatic but which still retains freedom of selectivity for obtaining good arc performance.

The dual continuous control, by the addition of self-indicating dials, enables the operator to set the machine for the proper volt-ampere characteristics, for the correct current and voltage to do any kind, type, or position of welding which may be required.

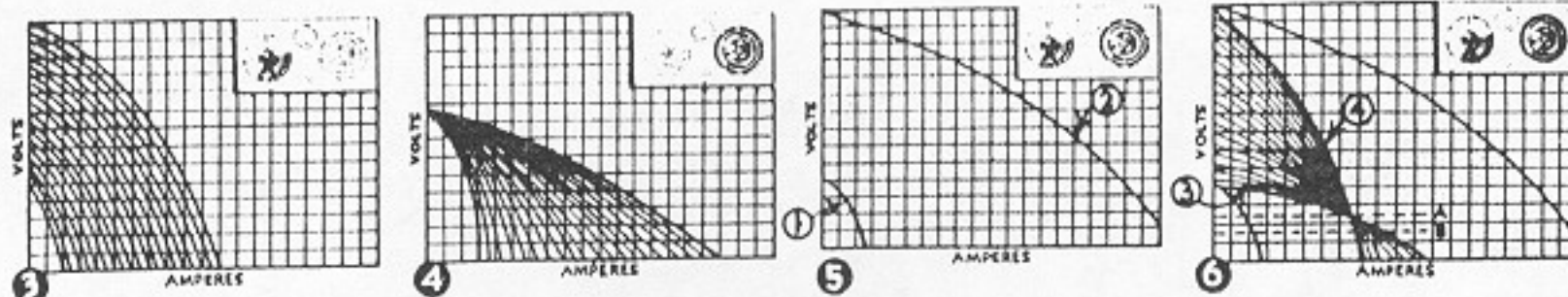
A welder with any degree of experience fully realizes the necessity for dual control of the arc in order to secure satisfactory welding results. He knows that for certain types of work he requires a volt-ampere curve of gradual slope, as indicated by a higher open-circuit voltage. Two welding applications can require the same welding current, but because of the difference in metals or welding conditions will require different open-circuit voltages.

Hence, for proper results, the welder finds it necessary to have control of both welding current and open-circuit voltage.

Open-circuit voltage and arc voltage are two separate and distinct things. (A) Open-circuit voltage is that registered or read on the machine when it is running but no welding is

Fig. 5. The combination of the two controls enables the operator to blanket the entire range of the welder.

Fig. 6. The operator can get varying penetration at any welding current with the dual continuous control.



being done (arc not in operation). (B) Arc voltage is the actual voltage across the arc while welding is being done (arc in operation). If the machine has a voltmeter, voltage indicated will be as follows: A—open circuit voltage—arc not in operation. B—arc voltage—arc in operation.

What effect does dual continuous control have on the performance of the welding arc? Consider what happens to the welding current when this control is operated.

By varying the left-hand control, the "job selector," the open-circuit voltage is changed, producing any desired volt-ampere curve such as those shown in Fig. 3.

Here's how dual continuous control varies penetration at any welding current.

By varying the right-hand control, the "current control," the welding current is changed with any given open-circuit voltage producing any desired volt-ampere curve such as those shown in Fig. 4. A great number of volt-ampere curves can be produced for each open-circuit voltage adjustment.

In other words, the combination of the two controls allows the operator to blanket the entire range of the welder as shown in Fig. 5. He can choose a volt-ampere setting which can be anywhere between the curve of lowest open-circuit voltage (Curve 1) and minimum current, and that of the highest open-circuit voltage and maximum current (Curve 2) (Fig. 5).

To see why the operator can get varying penetration at any welding current with dual continuous control, glance at Fig. 6. Select any welding current and its corresponding arc voltage such as the point A. Through that point, any number of volt-ampere curves can be produced, varying in slope as shown, from the gradually sloping Curve 3 to the steep Curve 4. (In actual operation this effect is produced by varying the open-circuit voltage with the left-hand control, while maintaining the same welding current with the right-hand control.)

Now, suppose the arc was shortened, decreasing the arc voltage to B.

It is clearly evident from the two curves that this shortening of the arc gives a material increase in the welding current for Curve 3, whereas it causes little effect in the current for Curve 4. The greater the pick-up in the current, the greater the penetration of the arc. It is, therefore, obvious that by varying the slope of the volt-ampere curve, we vary the penetration, and by means of dual continuous control this can be done to any desired degree at each and every desired value of welding current.

Both controls should be used to get the easiest operation. Any machine which does not have this feature cannot possibly give an arc of the same stability throughout the range of welding currents that is obtainable on this machine.

The setting of these self-indicating dials for desired results is extremely simple. The voltage control dial, on the left of the control box (Fig. 2), is divided into four segments, three distinc-

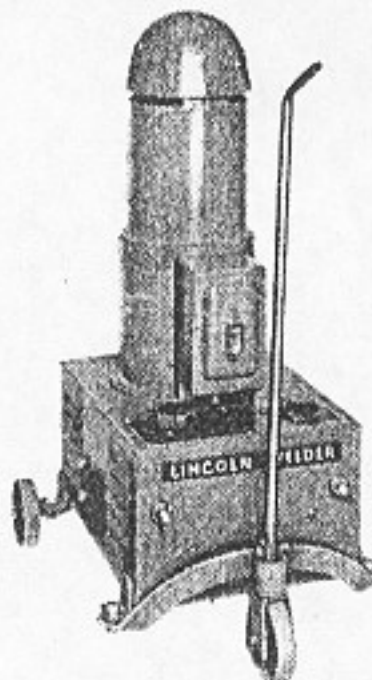


Fig. 7. A welder for work on light gauge metals requiring the use of small electrodes.

tively colored, which are labeled: large electrodes, normal welding, vertical and overhead, and a fourth segment in black for use with special low-current applications. The voltage setting labeled, "large electrodes," is the highest. Others are successively lower in the order named.

The current selector, or right-hand control (Fig. 2), consists of graduated current readings with a movable indicator which has three colored arrows corresponding to the distinctively colored segments on the voltage control.

In setting the machine, the operator should first choose that voltage setting which is required by the work and desired results.

Then by setting the arrow which corresponds in color to the segment indicated on the voltage control, the exact current suitable for the work may be obtained.

On each segment of the voltage control there is a control marking with smaller divisions on each side. When the voltage indicator is set at this control marking the current indicated by the same color arrow on the current control will be the current used at the arc. However, the voltage indicator may be varied above or below this central marking to obtain fine adjustments so that all conditions or job requirements may be met, the arc current varying correspondingly from that indicated on the current selector dial.

By means of these controls and dials, all guesswork has been eliminated in setting the machine. The "getting acquainted" period is no longer necessary. The required voltage and current with any desired volt-ampere characteristic may be accurately and quickly selected before the welding operation is begun.

The arc welding beginner should familiarize himself with this welder and its controls by experimenting with the settings and noting results.

The lessons in this series are planned for use with 200, 300, or 400-ampere welders. However, the ever-widening use of arc welding and the development of electrodes for light-gauge welding have indicated the need for a machine that would give the same easy, stable arc on light gauges with small electrodes as that obtained with larger machines on heavier work. The result is the unit shown in Fig. 7. The beginner will find it very easy to handle, and the experienced welder will appreciate its smoothness and that quality known as "feel of the arc."

Striking the Arc and Running Flat Bead



Fig. 1. Adapting an old auto frame for use on a special trailer, using a washed electrode.

WHILE the bare, dusted or lightly coated electrodes are used in a comparatively limited number of applications in industry generally, two lessons on this type of electrode are included here. One reason is that it is more difficult to hold an arc and to become a good welder with this sensitive type of electrode than it is with the shielded-arc or heavily coated type. Also, with the bare or washed electrode, it is easier for the student to see what actually takes place in the arc. He can thereby become familiar with the action taking place at the arc during welding. A welder who becomes proficient with bare electrodes and masters their sensitive operating characteristics can readily learn to use the shielded-arc electrode and will be the better welder. Constant practice with both kinds of electrodes makes the skilled welder.

Material needed for this study includes: scrap steel plate, and a 5/32-inch washed type electrode for general welding of mild steel in all positions, which conforms to American Welding Society Specification E-4511. A few of the many applications of this electrode are: filling holes, welding tanks for galvanizing, filler rod for larger gaps, well screens, repair of steel castings, tanks, build up work, cable way drums, building up shafts, ornamental iron, high silicon steel parts, castings, welds requiring galvanizing, stacks, hot water tanks. Figures 1 and 2 show this electrode being used for adapting old auto frame for use on a trailer and also for welding an 83-mile pipe line in 30 days.

Uniformity of this rod assures a steady, non-splashing arc, minimizing spatter and assuring clean, dense beads. Properties of all-weld metal

specimen (average, as welded, for various sizes of electrodes) are as follows: tensile strength—45,000 to 55,000 pounds per square inch; ductility 5% to 10% elongation in 2 inches; impact resistance—8 to 15 foot pounds Izod; fatigue resistance—12,000 to 15,000 pounds per square inch; density—7.5 to 7.7 grams/c.c.; corrosion resistance—fair.

POLARITY. "Straight polarity" and "reverse polarity" are often referred to. By "straight polarity" is meant that the negative side is the electrode and the positive side is the work. By "reverse polarity" is meant that the work is negative and the electrode

positive. Remember these terms carefully.

Use straight polarity, that is, make electrode negative (—), work positive (+).

Hold short arc. Tip of electrode should be just close enough to forward edge of crater to prevent sticking. A good short arc of proper voltage is usually indicated by a steady snappy crackling sound and steady shower of small sparks. Too long an arc will hiss and sputter.

FOR FLAT WORK

Rod Size	Amperage Range
3/32"	50-60
1/8"	85-125
5/16"	150-170
3/16"	190-210
1/4"	200-235

VERTICAL AND OVERHEAD WORK

Use slightly less current than for flat work—on lower side of above ranges.

Where a bead cannot be made in a straight run, use weaving. Weaving is a special waving, or oscillating, motion of the electrode and will be covered in detail in Lesson IV. Weaving helps keep the metal hot. It also aids in releasing gases and eliminating undercutting. Clean each bead with wire brush (Fig. 3) to remove oxides accumulated as molten metal cools.

SET UP. Place the plate on the bench and wire brush it to make sure it is clean.

The principal difficulty encountered in striking the arc is "freezing," that is, the electrode sticks or fuses to the work.

As high amperage, or current, flows the elec-

trode is practically short circuiting the welder. This heavy current melts the electrode and it sticks to the plate before it is withdrawn from contact. The high current will soon heat an electrode to red heat and then melt it, unless the circuit is broken by a rapid twist to holder.

There are two general schemes of striking the arc, although these are essentially the same. The first is to move the electrode toward the work, moving it down in a vertical direction. Just as soon as it touches withdraw it to the correct arc length (Fig. 4).

Sometimes this is rather difficult; so the second method, which is a variation of the first, consists in moving the electrode at an angle to the plate, sort of scratching the plate. The electrode will bump or rattle across the plate and form an arc. When this happens, withdraw the electrode to the proper arc length (Fig. 5).

Practice this by using 150 to 160 amperes with the $\frac{5}{16}$ -inch electrode.

Hold the electrode in a vertical position. Bring it to a point on the plate where the weld is to be made. Then hold it there without touching the plate until the hand shield is in front of your face. Touch the electrode very gently and swiftly to the work by a motion of the wrist. The movement in touching the plate should be somewhat rapid, then after that more slowly. Bring the electrode away from the plate about $\frac{1}{8}$ -inch or a little less than the diameter of the electrode. Hold arc for a few seconds only.

If the electrode sticks, or "freezes," give the holder a quick twist. This will generally free the electrode. If it does not and the electrode becomes red hot, it is necessary to open the circuit by letting go of the electrode with the holder or stop the welder by pushing in the stop button.

Caution: Never take hand shield or helmet away from the face if the electrode is stuck or frozen. Do all loosening of the electrode with shield over eyes.

Practice starting the arc and holding it, moving the electrode rather slowly over the plate until you are able to start the arc just as you desire. Move the electrode straight along so that there is no weaving motion of the holder but a

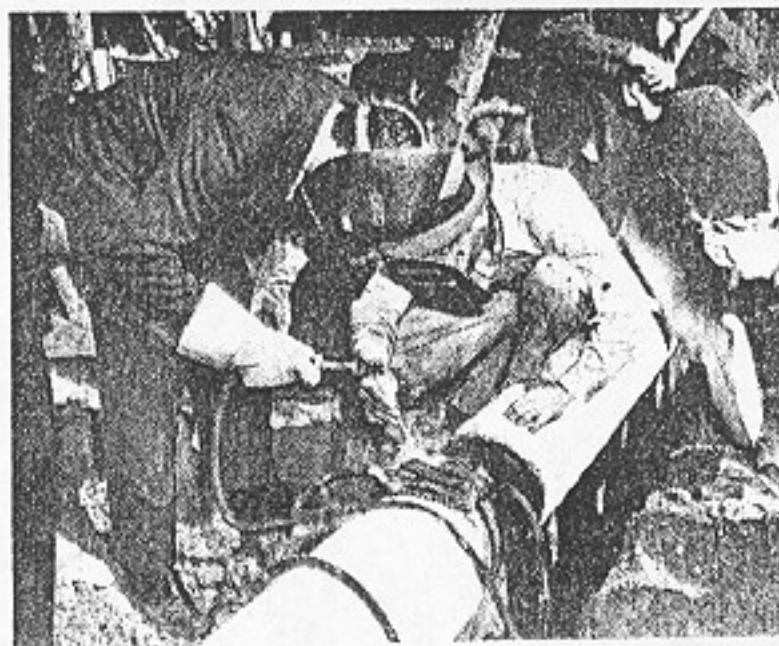


Fig. 2. Arc welding an 83-mile pipe line (for aviation gasoline production) in 30 days.

straight bead is obtained. Practice it again.

In the other method, this is, scratching the electrode on the surface, much the same procedure is followed (Fig. 5). Be careful that you do not move the electrode too fast. Allow the arc to be established and give the deposited metal time to penetrate into the parent metal. Keep the electrode just at the forward edge of the crater. The correct speed will be indicated by the bead being just the right size—not too thin and not built up too much (Fig. 6).

Continue this until you are able to start and stop the arc every time when and where you desire. Make lines, letters. Do not weave.

Examine the various beads and chip some of them off, look at them carefully. Keep this practice up until you can make the beads three or four inches long and of good appearance, even height, width, depth, no overlap or undercutting but good penetration.

When you stop the arc and then want to start again on the same bead, do as shown in Fig. 7.



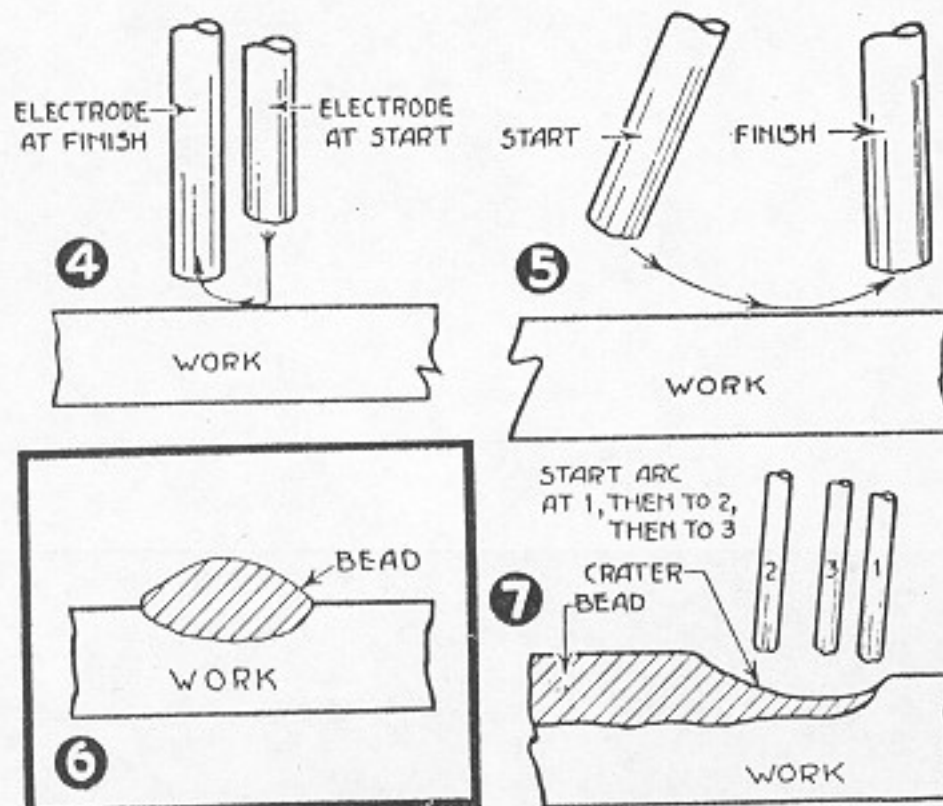
Fig. 3. A wire brush is used to clean beads, removing oxides accumulated as the molten metal cools.

Fig. 4. "Down-and-up" method of striking an arc.

Fig. 5. "Scratching" method of striking an arc.

Fig. 6. The bead should be not too thin nor built up too much.

Fig. 7. To rework the same bead, start the arcs in the order as numbered here.



Straight Bead with Weaving Motion

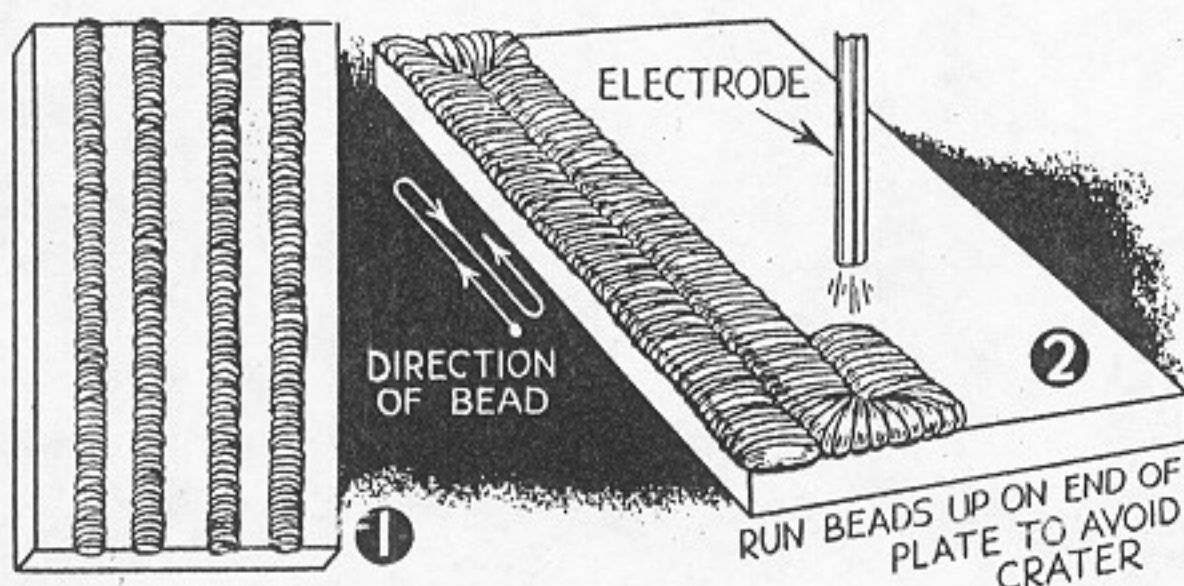


Fig. 1. Practice running beads and observe carefully the characteristics of the results you get.

Fig. 2. Practice welding in one direction to the end of the plate and then reverse the direction.

MATERIAL needed for this study includes: plate $\frac{1}{4}$ -inch or heavier and a $\frac{5}{32}$ -inch washed electrode. Set-up: clean the plate so that sufficient space is available, in order that the arc may be struck as indicated in Lesson 2.

Move the electrode slowly and steadily in a straight line along the plate away from you, proceeding in accordance with instructions of Lesson 2. Chip off the first bead. Notice how it looks. Inspect the penetration, the porosity, the overlap. Repeat this with the arc moving toward you. Then repeat the same with the arc moving from right to left and then from left to right. Check the length of the weld with the length of the rod used. Observe carefully the characteristics of the bead and try to find out what, if any, your difficulties are in making this bead (Fig. 1).

After you are able to weld straight-line beads, it is good practice to weld in one direction to the end of the plate, move slowly to the side and reverse direction of travel (Fig. 2).

Spend sufficient time on this exercise to become proficient in holding the proper length of arc and moving the electrode along the plate at the correct speed, so as to secure smooth, even beads as indicated in Figs. 1 and 2.

With the proper length of arc and rate of travel, there will be an exceedingly small amount of spatter produced.

With too long an arc (arc length should be slightly less than diameter of the electrode) there will be a noticeable increase of spatter; penetration will be poor; overlap will be noticeable; sound of the arc will be more of a hiss than a crackle; the metal will melt from the electrode in large drops.

If the rate of travel is too fast, the bead will be thin and stringy.

If the rate of travel is too slow, the metal will pile up and roll over with excessive overlap.

LESSON 3

The proper current for any given electrode is important to obtain proper shape of bead, proper penetration, minimum spatter. If too much current is used, bead will be flat with excessive spatter and quite porous and electrode will become red hot. If too little current

is used, the bead piles up with excessive overlap and with poor penetration and shallow crater.

Study the tabulation of "Resultant Weld Characteristics" obtained when proper welding procedure is used except as indicated. This tabulation applies only to welding of mild rolled steel in flat position with bare or washed electrodes.

The student should study the metal plate shown in Fig. 3 and its explanatory data in the tabulation below it. He should continue to practice until he is able to make a weld by correct procedure as indicated.

Weaving or Oscillating of Electrodes

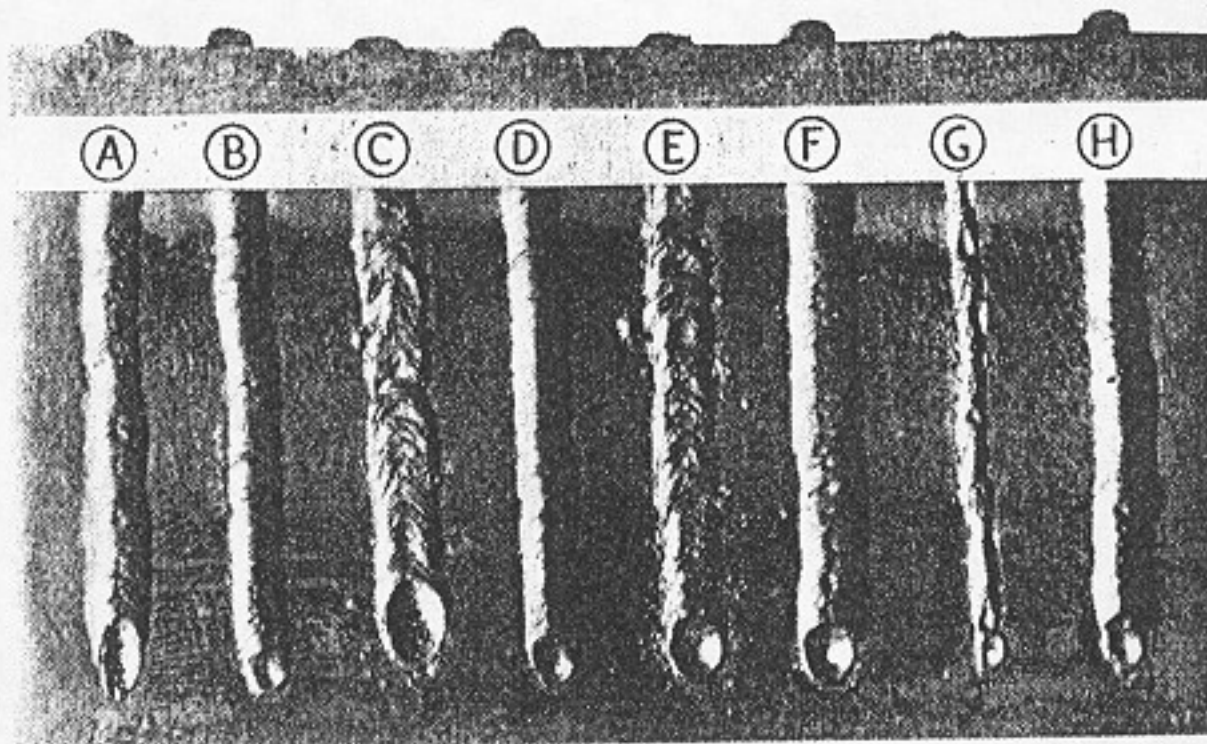
Material needed for this study includes: $\frac{1}{4}$ -inch plate, or any flat pieces of scrap and $\frac{5}{32}$ -inch washed rod. Set-up: prepare the plates with sufficiently clean surface so that the bead may be made several inches long. Place the plate in a horizontal position on the bench.

After the student has mastered striking the arc and running straight beads he is then ready to proceed with weaving, or oscillating, motion.

In order to float slag, allow gas to escape and avoid porosity or to deposit a wider bead for wider area, certain oscillating, or sidewise motion (weaving), of the electrode is necessary.

When steel is melted, some gas and slag are usually present. In order to allow the gas to escape and to float the slag to the surface for a sound weld, it is necessary that the metal be kept molten for a short period of time. In order to accomplish this and at the same time secure a narrow bead, a slight oscillation or movement parallel to the line of travel is necessary. This oscillation also helps to secure penetration at the edge of the weld in making the joint. Therefore, this is the first motion the student should study. (See A, Fig. 4.) This motion is really more lengthwise than is shown in the sketch. For purpose of illustration, a larger sidewise motion is shown than is actually used in practice. The motion is short and really lengthwise, rather than sidewise.

Fig. 3. (A) Weld made by correct procedure. (B) Result of correct procedure except use of low current. (C) Excessive current was used in making this weld. (D) Result of use of too short an arc. (E) Weld produced by too long an arc. (F) Result of too slow speed of travel. (G) Result of excessive speed of travel. (H) Use of wrong polarity always causes a poor weld.



For making a wide bead, it is necessary to weave the electrode slightly from side to side, at the same time proceeding forward along the line the bead is to be made. Such a weave is shown in B.

For accomplishing various purposes, variations of the B weave are widely used. Some students will find it much easier to weave in a crescent motion such as shown in C. The purposes accomplished by both these motions are substantially the same and their use is largely a matter of preference. A figure 8 motion such as shown in D is preferred by some welders.

While the student has not yet attempted to make any kind of joints or actual welds, certain weav-

RESULTANT CHARACTERISTICS WITH WASHED ELECTRODE

Operating Variables	Resultant Weld Characteristics				
	Arc Sound	Penetration-Fusion	Turn Off of Electrode	Appearance of Bead	Comments
(A) Normal polarity, correct current, voltage and speed of travel	Steady, sharp crackling sound	Good. Crater averages $\frac{1}{16}$ " deep for $\frac{1}{8}$ " rod	Stable	Smooth, no overlaps	
(B) Low current	Pulsating "low energy"	Poor. Very shallow crater		Bead piles up. Overlap	
(C) High current	Explosions crackling	Poor weld characteristics. Porosity		Flat	Electrode becomes red hot. Splatter. Porous weld.
(D) Low voltage (across arc)	Steady sputter	Poor. Crater shallow	Rod apt to freeze to work	High	
(E) High voltage (across arc)	Whistling or hissing and crackling	Very little fusion. Crater shallow	Bubble on end of rod. Arc wanders	Flat	Splatter. Pockets in weld. Weld oxidizes
(F) Low speed of travel		Crater excessively deep		Piles up and rolls over. Bluish color	Electrode becomes red at tip splatter
(G) High speed of travel		Almost no crater. No fusion		Irregular in width. Flat	
(H) Reverse polarity	Sputter	No crater. Porosity		Irregular	Splatter

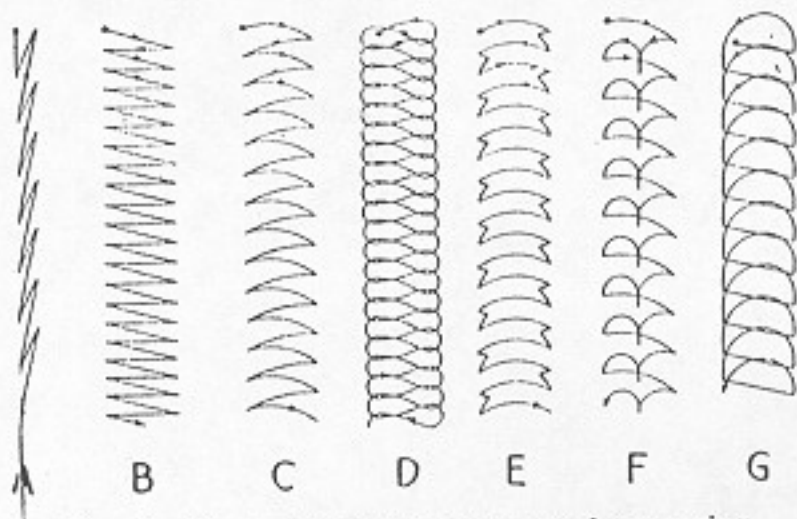


Fig. 4. Seven different movements in weaving electrode from side to side in running beads.

ing motions are desirable to accomplish certain results. One such weave is shown in E. The purpose of such a weave is to allow a slight hesitation at each side of the weave. The purpose of this is to allow a slight building up or working of the metal into the edges of the joint.

Perhaps the most commonly used weave is that of C.

Many welders have their own ideas of the best type of weave for various purposes. Two of such weaves are shown in F and G.

The student should practice the motion shown in A, B, and C until he is able to make a narrow bead of proper shape, of sound metal and surface of even ripples.

The student should next practice working beads $\frac{1}{2}$ -inch to $\frac{3}{4}$ -inch wide, using B weaving motion. He should continue practicing until he is able to make bead of such proportions which is of sound metal with smooth rippled surface and with proper penetration.

Movements C and D should be practiced until the student can obtain the same smooth type of bead mentioned for B.

While the student is practicing weaving, it is

recommended that he practice E type of weave in the form of a bead in flat plate so that the motions will become second nature and will be done automatically, when required. Such a bead will be smooth and rippled like those shown under B, C, and D, and if a wide bead is made with such a weave, the metal at the edge of the bead will be a trifle higher than at the exact middle. Continued practice is recommended to all students.

Shielded Arc Welding and Its Uses

LESSON 4

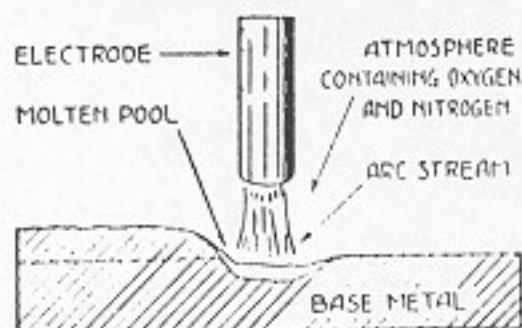


Fig. 1. How the atmosphere has access to the molten metal when the unshielded arc is used.

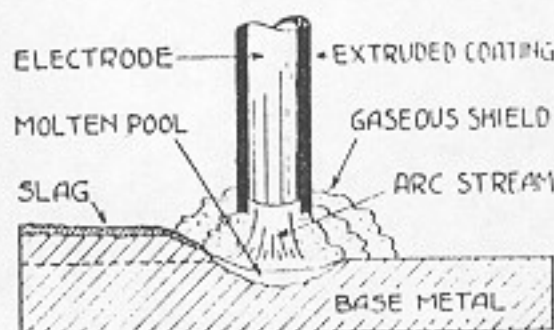


Fig. 2. The shielded arc provides a gaseous protection for the fusion of the electrode and base metals.

HAVING served the purpose for which they were included in Lessons 2 and 3 (to inform the student of their sensitive operating characteristics in order that he may more readily learn how to hold an arc and more easily discover just what takes place during welding) bare electrodes have no further place in these lessons except to clarify the discussion of shielded arc welding in this one.

Henceforth, the instructions will be on the use of coated (shielded-arc type) electrodes since they are now almost universally employed and will, consequently, provide more useful and valuable information. Before he proceeds, however, it is important that the student be proficient with bare electrodes since proficiency in their use will enable him to learn welding

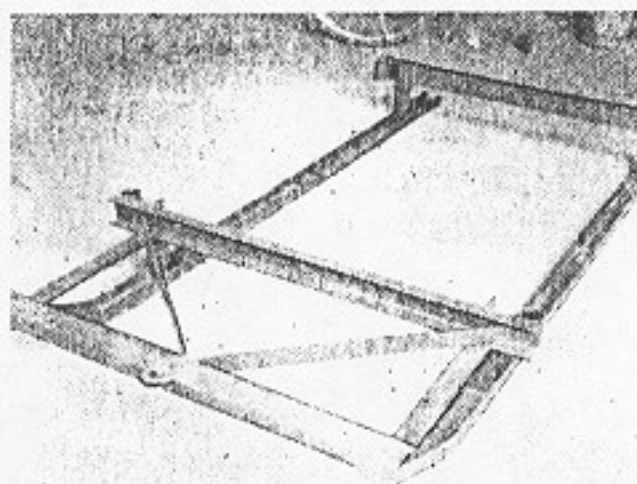


Fig. 3. Alterations to frames for automotive use are quickly made by arc welding.

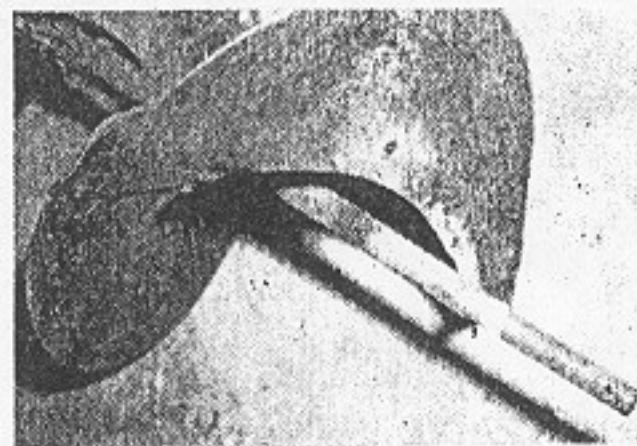


Fig. 4. Broken axles, as on this manure spreader, are easily repaired by welding.

readily with coated electrodes and thus become a better welder.

Material needed for this study includes $\frac{3}{8}$ -inch plate; $\frac{3}{16}$ -inch shielded-arc type electrode.

Before doing any actual welding it is well to see what shielded arc welding is and how it works.

It is common knowledge with those familiar with arc welding that the molten weld metal as it is being deposited has an affinity for oxygen and nitrogen. Since the arc system is maintained in an atmosphere composed chiefly of these elements, oxidation proceeds during the passage of the weld metal from electrode to work. In this way

oxides and nitrides are formed in the weld metal. And these oxides and nitrides in the weld metal reduce its strength, ductility and resistance to corrosion.

If the molten weld metal is protected from contact with atmospheric oxygen and nitrogen

PROPERTIES OF WELD METAL

	Tensile Strength #/ sq. in.	Elongation in 2"	Impact Ft. Lbs. (Izod)	Fatigue Lbs. per sq. in.	Density	Corrosion Resistance
Shielded-Arc (Fleetweld) (coated electrode)	65,000 to 77,000	20% to 26%	30 to 70	28,000 to 32,000	7.84 to 7.86	Better than mild steel
Unshielded Arc (bare electrode)	45,000 to 55,000	5% to 10%	8 to 15	12,000 to 15,000	7.5 to 7.7	Poor

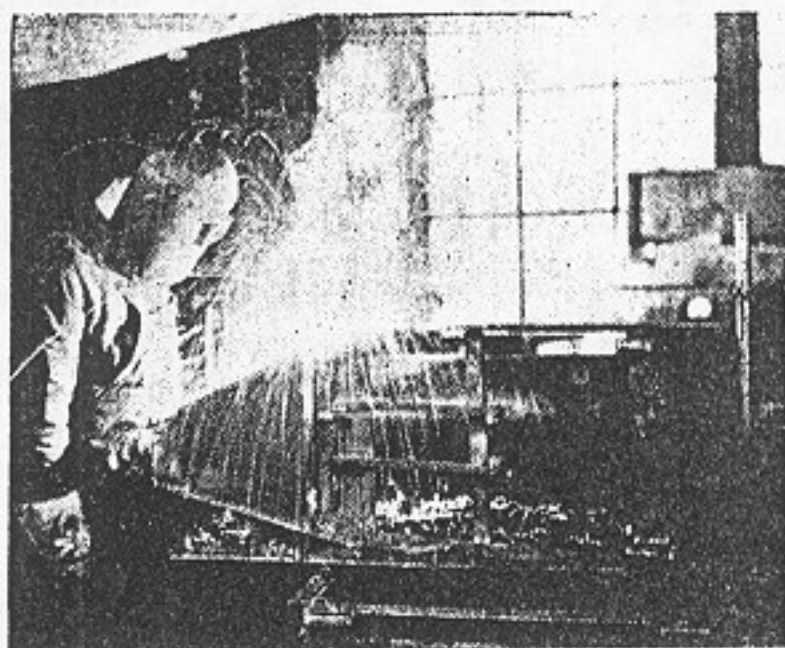


Fig. 5. Welding speeds up the production of "scooter" frames for handling bombs.

during the process of deposition, the weld so produced will be free of oxides and nitrides. Thus an arc, completely shielded from oxygen and nitrogen, deposits weld metal superior to that deposited by an ordinary arc.

UNSHIELDED ARC. In Fig. 1, it can be seen that the atmosphere has ready access to the metal while it is molten. Compare this with what happens when the atmosphere does not have access to the molten metal, as shown in Fig. 2.

SHIELDED ARC. It will be noted that the shielding is obtained in three ways. First, in the case of electrodes such as "Fleetweld 5" the coating is consumed slower than the metal melts so that the coating, during welding, projects over one end of the metal electrode. Second, as the coating is consumed it forms an inert gas around the molten metal excluding the atmosphere. Third, a slag is formed over the deposited metal protecting it from the atmosphere.

Welds properly made with shielded arc rods are so far superior to welds made with bare electrode or with unshielded arc that it is almost unbelievable. Study the comparison in the tabulation entitled, "Properties of Weld Metal."

Shielded arc weld metal can be flanged or bent cold with complete success, which is impossible with weld metal made by the unshielded arc.

With a bare or washed electrode, a short arc is used, the arc voltage being in the order of 18-22 volts.

The shielded arc electrodes operate at somewhat higher arc voltages (20-40 volts) because of the gas around the arc. Shielded arc electrodes should be used with a fairly close arc, but never so short that the coating touches the molten metal, otherwise porosity may result.

In work on implements and tractors, for illustration, a welder will have many uses for mild-steel welding with coated (shielded-arc type) electrodes. Some of these uses may be: construction, repair, or alterations to frames (Fig. 3); and repairing manure spreader axles (Fig. 4). And, in Fig 5, is shown welding work being done on a "bomb scooter" frame.

GENERAL DESCRIPTION. "Fleetweld 5," one of several of this name for particular welding jobs, is a shielded-arc electrode for high speed, quality welding of mild steel in all positions—flat, vertical and overhead.

GENERAL INSTRUCTIONS. Polarity—make electrode positive and work negative.

Flat Welding. Hold a fairly close arc but never so short that the coating touches the molten pool. Weave if required. Current should be about middle of ranges given below. Clean each bead thoroughly before applying the next.

Vertical and Overhead Welding. Use only $\frac{1}{8}$ -inch size where joints are tight, $\frac{5}{32}$ -inch for all normal spacings and $\frac{3}{16}$ -V for upper beads on heavy plate and finish beads. Hold short arc but do not allow coating to touch molten pool.

In vertical welding, start at top and weld down. However, with heavy plate, some welders prefer to weld from bottom up. In overhead welding, build the weld with several narrow beads, the idea being always to keep the molten pool as small as possible. Do not weave a wide bead. Clean each bead before applying the next one.

FLAT WELDING

Rod Size	Amperage Range
$\frac{1}{8}$ "	75-150
$\frac{5}{32}$ "	90-200
$\frac{3}{16}$ "	140-350
$\frac{7}{32}$ "	160-400
$\frac{1}{4}$ "	175-500
$\frac{5}{16}$ "	250-625
$\frac{3}{8}$ "	300-750

VERTICAL AND OVERHEAD WELDING

Rod Size	Amperage Range
$\frac{1}{8}$ "	75-140
$\frac{5}{32}$ "	110-160
$\frac{3}{16}$ " V	125-180

Place the plate on the welding table and the electrode in the holder. Practice striking the arc, following generally the instructions given in Lesson 2. The student will find that this is much easier than with bare electrode. The arc should be broken by lengthening it until it goes "out," i.e., the electrode should be drawn slowly away from the plate. After breaking the arc, the student should practice striking the arc again on the same bead by starting slightly ahead of the crater—then moving backward slightly to the rear end of the crater.

The student should practice this exercise until he can do it smoothly and easily, and without leaving any perceptible depression or hump.

The student is now ready to start running beads.

Move the electrode slowly and steadily along the plate and away from the operator. He should try to run the bead in as straight a line as possible. He should practice making parallel beads a slight distance apart (see Fig. 1, in Lesson 3) and should repeat this until he is able to make a smooth even bead without undercut or overlap.

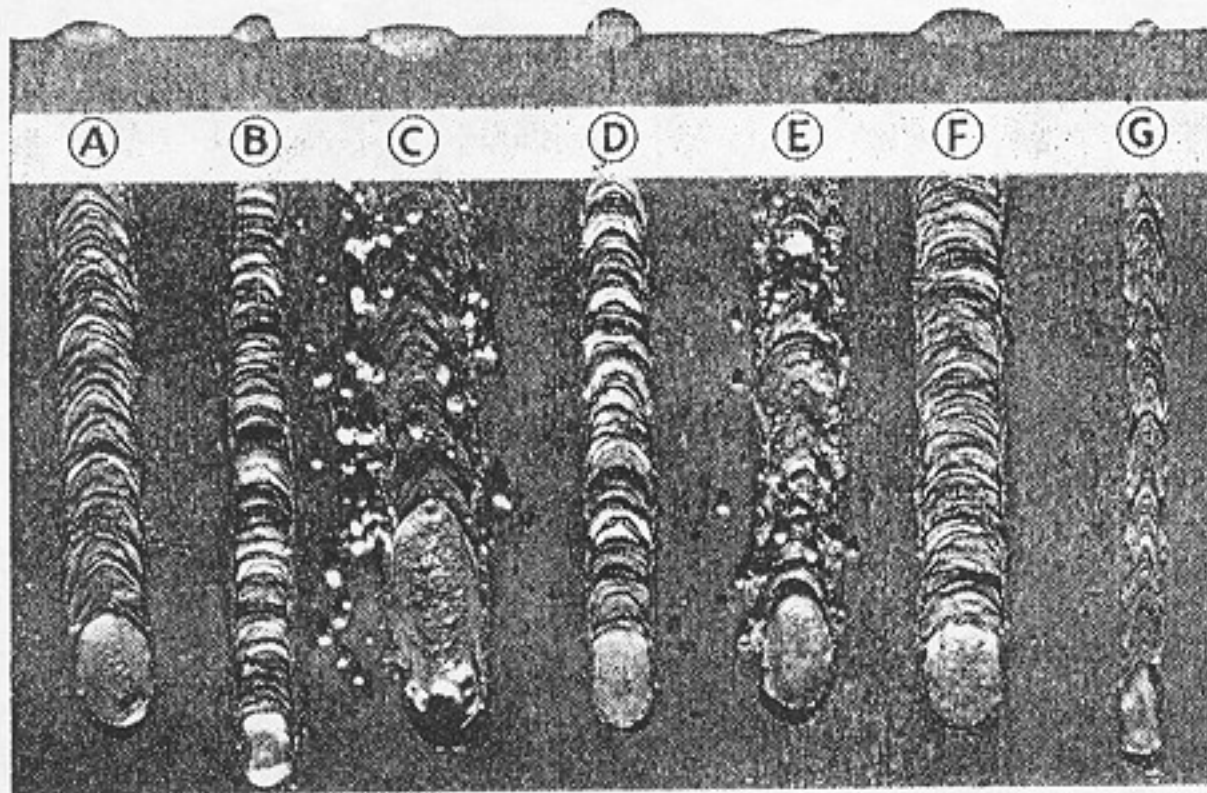


Fig. 6. Plan and elevation views of welds made with shielded arc electrodes under various conditions. (A) Current, voltage and speed normal. (B) Current too low. (C) Current too high. (D) Voltage too low. (E) Voltage too high. (F) Speed too low. (G) Speed too high.

RESULTANT WELD CHARACTERISTICS WITH SHIELDED ARC

Operating Variables	Resultant Weld Characteristics			
	Arc Sound	Penetration Fusion	Burn off of Electrode	Appearance of Bead
(A) Normal Amps. Normal Volts Normal Speed	Sputtering hiss plus irregular energetic crackling sounds	Fairly deep and well defined	Normal appearance. Coating burns evenly	Excellent fusion and no overlap
(B) Low Amps. Normal Volts Normal Speed	Very irregular sputtering and few crackling sounds	Not very deep nor defined	Not greatly different from above	On top of plate. Note overlap is not such as on bare rod
(C) High Amps. Normal Volts Normal Speed	Rather regular explosive sounds	Long and deep crater	Coating is consumed at irregular high rate. Watch carefully	Broad rather thin bead. Good fusion
(D) Low Volts Normal Speed Normal Amps.	Hiss plus steady sputter	Small	Coating too close to crater. Touches molten metal and results in porosity	Sits upon plate but not so pronounced as for low amps. Somewhat broader
(E) High Volts Normal Speed Normal Amps.	Very soft sound plus hiss and few crackles	Wide and rather deep	Note drops at end of electrode. Flutter and then drop into crater	Wide and splattered
(F) Low Speed Normal Amps. Normal Volts	Normal	Crater normal	Normal	Wide bead and overlap large. Base metal and bead heated to considerable area
(G) High Speed Normal Amps. Normal Volts	Normal	Small and rather well-defined crater	Normal	Small bead and undercut. The reduction in bead size and amount of undercutting depends on ratio of high speed and amps.



Fig. 7. When bent, the bare electrode weld (lower) will crack quickly, while the shielded-arc weld (upper) bends double without cracking.

Inspect the beads carefully. The first thing that will strike you as unusual is the slag.

"Fleetweld" has been designed so as to leave a slag which is highly desirable. As noted before the gas caused by the coating being consumed excludes the air from the molten metal as it goes across the arc. However, as the arc moves along, the metal might be exposed to the air before it solidified were it not for the slag which covers the molten metal and effectively excludes the air until it solidifies and cools. This slag covering also decreases the rate of cooling some-

what, thus helping in the annealing effect on the weld metal.

However, it is desirable that this slag be easily removable, and the operator should remove all slag before proceeding with the next bead. This can be accomplished very easily by scraping the corner of a chisel or old file along the edges. It will be found that the slag comes off quite readily if allowed to cool. A scraping action as mentioned will cause a great deal of it to crack off. Finish slag removal by using a wire brush. Other

means such as sand blasting, air hammer, etc., are used.

After this, chip the bead. See the kind of weld metal deposited. Study it closely.

After the student is able to weld in a straight line with bead of proper appearance, it is good practice to weld in one direction to the end of the plate, move slowly to the side and reverse the direction of travel (see Fig. 2, in Lesson 3).

By this time the student has observed that the amount of current, length of arc, speed of travel, etc. has a considerable effect on the type of bead he is able to produce. He should study Fig. 6 and the tabulation beneath it closely, so as to be able to tell when he is making a good bead and when a bad bead results what caused the trouble. This tabulation of resultant weld characteristics obtained when welding is done in mild rolled steel with heavily coated shielded arc electrodes and when proper welding procedure is used except as indicated. See Fig. 6. In later work, this data will also enable him to tell from visual inspection whether the bead or weld was made under proper conditions.

After the student has become proficient in running a bead, it will be interesting to take a piece of $\frac{1}{4}$ -inch mild steel and lay a bead with washed electrode and parallel to it lay a bead with

shielded arc electrode and then bend the plate with the beads on the outside. He will note (Fig. 7) that the bare electrode weld (lower one) will crack soon while the shielded-arc weld (upper) can be bent almost double without cracking. This should convince the student of the high quality of weld metal deposited with shielded-arc welding.

The student who wants experience with other electrodes for various applications in mild steel work has access to "Fleetweld 7" for high-speed single or multiple-pass welding where fit-up is poor; "Fleetweld 8" for high-speed fillet welding in flat position; "Fleetweld 9" for deep-groove joints in heavy plate in flat position; "Fleetweld 10" for the last pass in multiple pass, down-hand welds. Practice with these electrodes, and plenty of it, will be good experience for any student welder.

Flat Position Welding of Lap, Tee, and Butt

LESSON 5

MATERIAL needed for this study includes: two pieces $\frac{1}{4}$ -inch plate; two pieces of $\frac{1}{2}$ -inch plate; $\frac{3}{16}$ -inch shielded arc type electrodes.

Welders are called upon, at one time or another, not only to make different types of welded joints such as lap, tee (or fillet), and butt, but also to make such welds in different positions, such as flat, horizontal, vertical and overhead.

In order, therefore, that the student may become familiar with the fundamentals of welding various joints in different positions for maintenance and construction machinery, this Lesson 5 covers flat welding (Figs. 1, 2, and 3), while Lesson 6 covers horizontal, Lesson 7 vertical, and Lesson 8 overhead welding.

Always fit up work so that there is no appreciable gap. Speed of welding, current, and quality of weld all vary directly with fit up. The electrode is held as in Fig. 4.

The angle between the electrode and horizontal plate being 45 degrees pointing backwards to make an angle of 60 degrees between electrode and vertical plane. The arc is played on extreme corner of upper plate. Do not weave the arc. Draw the electrode along in straight line watching carefully the solidifying bead. Advance the arc at proper rate so that full weld is made.

TABLE A—FOR EXERCISE A

Plate Thickness	Wire Size	Current
$\frac{1}{8}$ "	$\frac{1}{4}$ "	250
$\frac{3}{16}$ "	$\frac{1}{4}$ "	250
$\frac{1}{4}$ "	$\frac{1}{4}$ "	250
$\frac{5}{16}$ "	$\frac{1}{4}$ "	250
$\frac{3}{8}$ "	$\frac{1}{4}$ "	250

EXERCISE A. Place two pieces of $\frac{1}{4}$ -inch

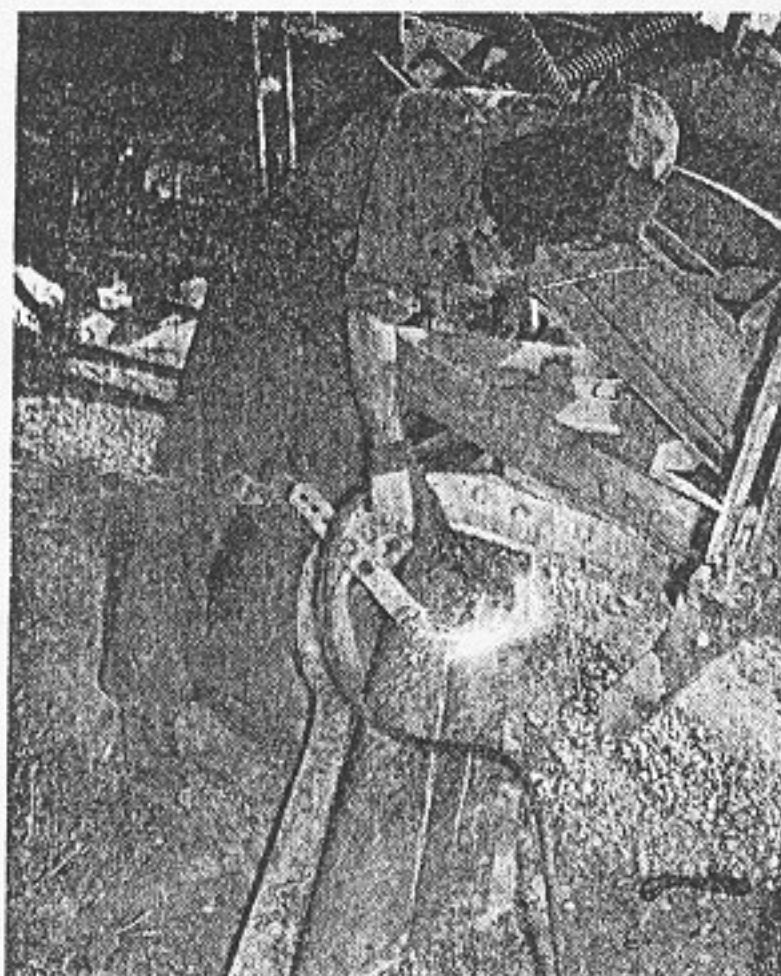


Fig. 1. Flat welding of a bracket to scraper blade.

plate on the table so they overlap about 2 inches and tack weld them together. Make a weld using the current indicated in Table A. Hold the electrode as shown in Fig. 4. Proceed straight along the joint without weaving or oscillation. Make sure slag floats to the surface.

Clean the bead and examine it to make sure that a smooth bead is obtained. Break the plates apart to make sure that full penetration is secured in the corner.

Be sure no overlap is present.

If possible, repeat with different thicknesses of plate as indicated in Table A.

When the work can be tilted so that the molten pool of weld metal will be approximately horizontal, much higher welding speed can be obtained. Tilting of the plates about 5 degrees will usually be sufficient to speed up the welding. Care should be taken, however, to avoid undercutting in the bottom plate.

EXERCISE B. See Fig. 5. When a welding generator of sufficient size is available, larger size electrodes and higher currents can be used with resulting increase in speed.

See Table B for approximate sizes of electrodes for different thicknesses of plate.

If machines are not available of sufficient capacity to handle $\frac{1}{4}$ -inch electrode, the student can practice this exercise using $\frac{3}{16}$ -inch electrode, in which case a slight oscillation may be used. Be careful of undercutting in bottom plate.

TABLE B—FOR EXERCISE B

Plate Thickness	Wire Size	Current
$\frac{3}{16}$ "	$\frac{5}{16}$ "	375
$\frac{1}{4}$ "	$\frac{5}{16}$ "	375
$\frac{3}{8}$ "	$\frac{3}{8}$ "	425

Tee or Fillet Weld in Flat Position

Material needed for this study includes: $\frac{1}{4}$ -inch plates; $\frac{1}{4}$ -inch shielded arc electrode.

The electrode is held in the position shown in Fig. 6, the angle between the electrode and the horizontal plate being 30 degrees and pointing backwards to make an angle of 60 degrees between electrode and the vertical plate.

The arc is held somewhat shorter than on previous welds and directed into the corner if the plates are of the same thickness. In case the plates are of unequal thickness, the arc is directed a bit more on the thicker plate. The



Fig. 2. These six welders are working on a pusher head of a scale breaker which broke in service, in a steel mill. Welding had the part back in operation in eight hours, preventing a prolonged shut down of the entire mill.

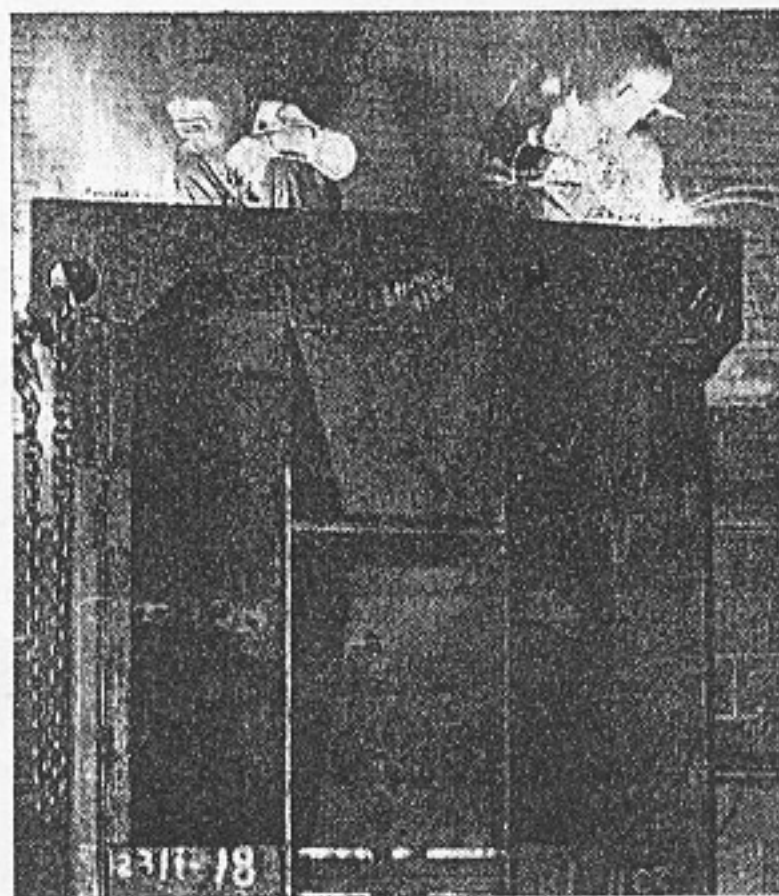


Fig. 3. Arc Welders are fabricating this machine base from slabs of strong steel.

point is to heat both plates to about the same temperature.

In making this type of weld, do not weave the arc. Simply draw the electrode along in a straight line and watch carefully the solidifying bead. Directly under the arc there may be considerable undercutting of the vertical plate. However, if the arc is advanced at the proper rate, the bead will pile up and solidify to fill in the undercut and result in a good fillet weld. This will result in a bead of approximately $\frac{1}{4}$ -inch size.

TABLE C—FOR TEE OR FILLET FLAT WELDS

Plate Thickness	Wire Size	Current
$\frac{3}{16}$ "	$\frac{1}{4}$ "	190
$\frac{1}{4}$ "	$\frac{1}{4}$ "	190
$\frac{3}{8}$ "	$\frac{1}{4}$ "	190
$\frac{1}{2}$ "	$\frac{1}{4}$ "	190

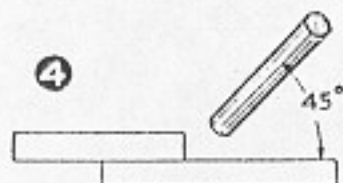
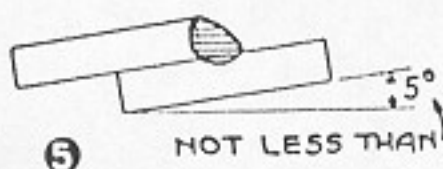
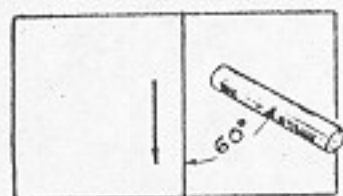
Note: For $\frac{1}{2}$ -inch plate use bead procedure Fig. 7.

Where such a fillet weld can be positioned as shown in Fig. 8 much higher currents and increased speed can be obtained; positioning should be such that the molten pool is horizontal.

TABLE D—FOR POSITIONED FILLETS

Plate Thickness	Electrode Size	Current
$\frac{1}{2}$ "	$\frac{3}{8}$ "	350

EXERCISE C. Place plate on table. Tack weld another plate to it at right angles as in Fig. 6. Make a weld using $\frac{1}{4}$ -inch electrode, drawing the electrode along in a straight line without weaving. Clean bead and examine carefully. Break the weld to see if complete penetration in



Figs. 4 and 5. Position of base metal, electrode, and bead in flat welding of lap joint.

corner and clean metal are secured. Practice until proficient.

Try making heavier weld using slight weave or oscillating motion. Practice until good bead without undercutting and with complete penetration in corner is obtained.

Many heavy fillet welds require more than one bead. Proper procedure and currents for such welds are given in the sketches and Table E. Be sure to clean previous beads before making new ones.

TABLE E—FOR MORE THAN ONE BEAD

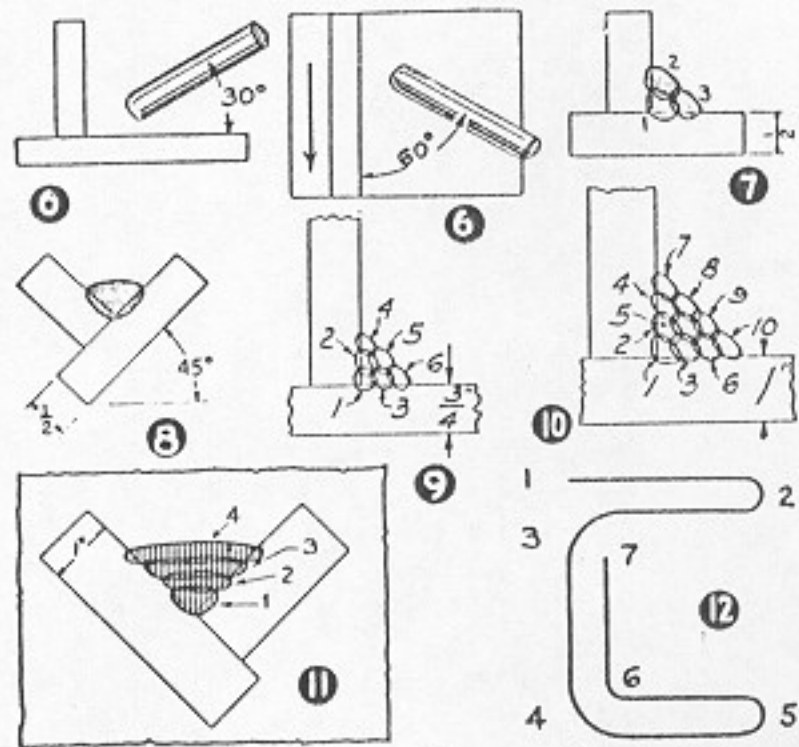
Plate Thickness	Passes	Electrode Size	Current Amps.
Fig. 9			
3/4" plate	6	1/4"	190
Fig. 10			
1" plate	10	1/4"	190

EXERCISE D. If possible, the student should practice making welds on 1/2-inch plate using procedure shown.

Positioned Fillets

If fillet welds can be positioned as shown in Figs. 8 and 11, larger sized electrodes can be used and consequently much greater speeds secured.

EXERCISE E. If a machine of sufficient capacity is available, it is recommended the student try making welds with work positioned as indicated.



Figs. 6 to 12. Position of base metal, electrode, and bead in flat welding of tee joint.

In making these welds, first pass should be made by drawing the electrode along in a straight motion. Second, third, etc. passes are made with weaving motion as shown in Fig. 12.

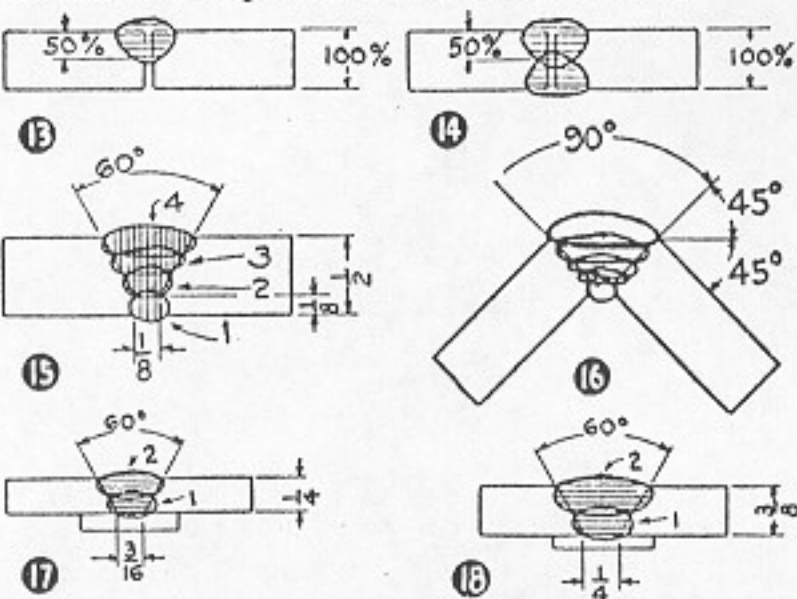
Butt Welds in Flat Position

Material needed for this study includes: steel plates of various thicknesses; shielded-arc type electrodes of various sizes.

EXERCISE F. Place two of the 1/4-inch plates on the table with two square edges tacked together. See Fig. 13.

Strike arc at one end of joint, draw electrode along joint in a straight line to produce a bead as shown.

Electrode sizes and currents for different thicknesses of plate are shown in Table F.



Figs. 13 to 18. Position of base metal, electrode, and bead in flat welding of butt joint.

Break weld apart for examination of weld metal.

For full penetration (100%), plate may be turned over and similar weld made on the other side. See Fig. 14.

Currents and electrode sizes are given in Table G.

TABLE F. SEE FIG. 13

Type of Joint	Plate Thickness	Pass	Wire Size	Current
1	3/16"	1	1/4"	190
1	1/4"	1	5/16"	300
1	3/8"	1	5/16"	425
1	1/2"	1	3/8"	500
Approximately 50% penetration welding from one side. The structure in this type of weld varies with the analysis of the plate.				

TABLE G. SEE FIG. 14

Type of Joint	Plate Thickness	Passes	Wire Size	Current
2	3/16"	2	1/4"	190
2	1/4"	2	5/16"	300
2	3/8"	2	5/16"	425
2	1/2"	2	3/8"	500
Approximately full penetration welding from two sides. The structure in this type of weld varies with the analysis of the plate.				

EXERCISE G. After the student has become proficient in making the square groove joint, he should have a heavier plate, $\frac{3}{8}$ -inch or $\frac{1}{2}$ -inch prepared with bevel as shown in Fig. 15.

Place these on the table with approximately $\frac{1}{8}$ -inch spacing at the bottom. Lay one bead at the bottom, the length of the plate, using slight oscillating motion. Clean slag and brush carefully before proceeding. Run second, third and fourth beads, or enough to fill the vee with slight reinforcement or extra metal on the last bead. For second bead, use a slight weaving motion. On later passes, use weaving motion as shown in Fig. 12.

It may be difficult to secure plates beveled. If so, an approximation sufficiently accurate for practice can be secured by utilizing square edged plates, placed at an angle as shown in Fig. 16.

If machine shop is available for preparation of plates, the student may practice making U-joint welds using procedure similar to that for vee joints.

Sometimes in making butt joints of the V or U type, a backing-up strip is used, in which case larger electrodes and higher speeds can be used.

TABLE H—USING A BACKING-UP STRIP

Type of Joint Plate Thickness	Passes	Wire Size	Current
$\frac{1}{4}$ "	First	$\frac{5}{16}$ "	325
	Second	$\frac{3}{8}$ "	425
$\frac{3}{8}$ "	First	$\frac{5}{16}$ "	325
	Second	$\frac{3}{8}$ "	425

Welding from one side into steel backing strip 100% strength. See Figs. 17 and 18.

Horizontal Welding of Lap and Butt Joints

LESSON 6

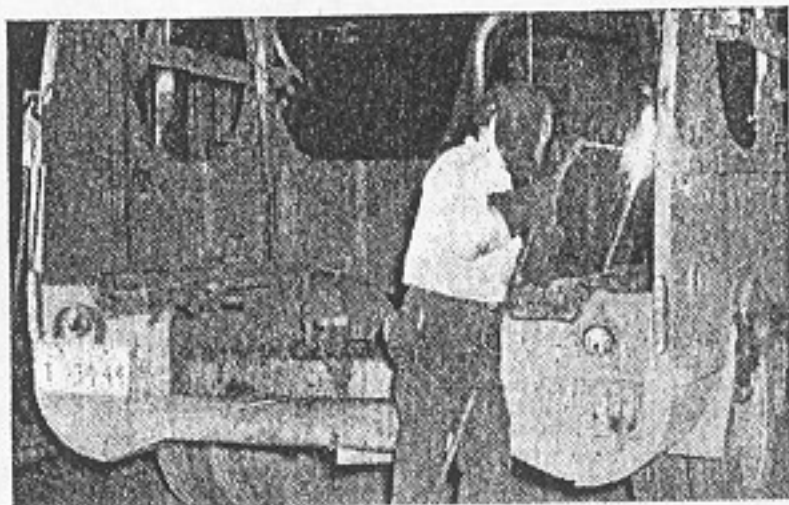


Fig. 1. Horizontal welding in making alterations to auto transport trailer.

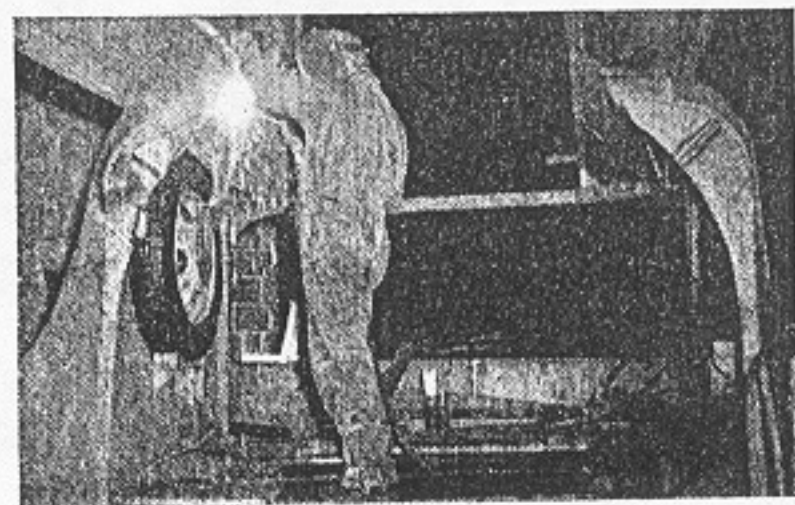


Fig. 2. Horizontal welding in extending the framework of transport trailer.

MATERIAL needed for this study includes: steel plates $\frac{1}{4}$ -inch thick; $\frac{5}{32}$ -inch shielded arc electrodes.

Continuing the discussion of different types of welded joints and welding in different positions, brings up the subject of lap and butt welds made horizontal. As previously pointed out, the welding student will be called upon to weld the different types of joints discussed in these lessons.

It will, therefore, be well for him to become entirely familiar with the procedures so that he can use the arc welding process to best advantage in his work.

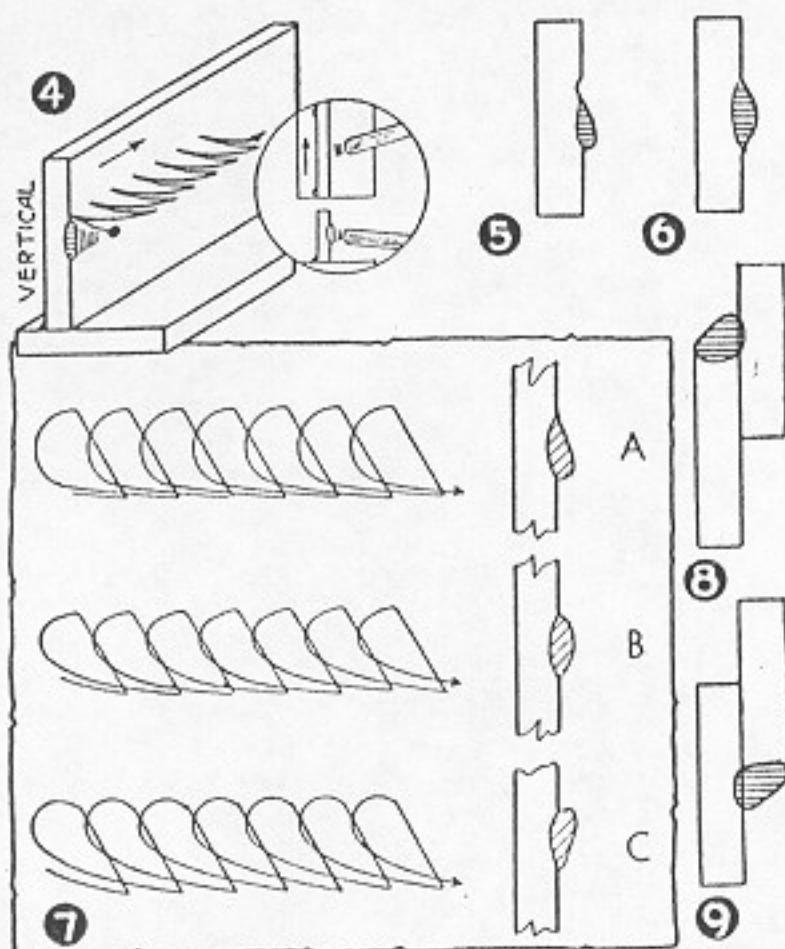
The student will find it necessary at times to make what is known as horizontal welds. These are welds on plate which is in the vertical position, but the bead or weld runs in a horizontal position, parallel to the ground (Figs. 1, 2, and 3), rather than up and down as in the so-called vertical welding.

To study horizontal welding, set the plate on the welding table in a vertical position. If necessary, to hold in this position, tack it to a flat plate (Fig. 4). The electrode should be held approximately perpendicular to the vertical plate; however, pointing back and upward, approximately 15 to 20 degrees. See insert in Fig. 4.

The student should strike an arc at the left-hand end of the vertical plate and draw the arc along the vertical plate in a horizontal line, attempting to make the arc deposit molten metal on the vertical plate. He will note that while it is comparatively easy to maintain the arc while doing this, it is rather difficult to get a smooth, well-shaped bead, the tendency being for the molten metal to run down the plate on the bottom side of



Fig. 3. Horizontal welding of bracket to side of trailer.



Figs. 4 to 9. Position of base metal, electrode, and beads in horizontal welding of lap joints in vertical position.

the bead. The appearance of this bead will be similar to Fig. 5. However, the student should continue to practice this until he can maintain the arc steadily and smoothly along a straight line without difficulty. Cutting down the current will assist the student in getting a bead of best shape.

To assist in overcoming irregularity of bead, use a slight weaving motion as in Fig. 4.

The student should continue practicing until he gets a bead of approximate shape of Fig. 6. He will find it helpful to "crowd the arc" at the top of the weave. By "crowding the arc" is meant shortening of the arc.

For wider beads, the student will find a somewhat more extensive weaving motion necessary. Three weaving motions and their corresponding shape of bead are given in Fig. 7.

The student should continue to practice these weaving motions until he is proficient and able to make good, even beads of the approximate shapes shown.

Horizontal Lap and Butt Joints

Material needed for this study includes: steel plate $\frac{1}{4}$ -inch and heavier if available, prepared as indicated; $\frac{5}{32}$ -inch shielded arc type electrode.

There are a number of horizontal joints such as butt, lap, etc. The lap type of joint (Fig. 8) is very similar to the regular fillet weld and need not be discussed. The lap joint shown in Fig. 9 is made very much like the overhead fillet weld, and after the student has mastered overhead welding, no difficulty will be encountered. Since these two types of joints are so similar to other types, this lesson will cover largely the

horizontal butt joint. Study it carefully.

For practice only, the student should try making the horizontal lap joint shown in Fig. 8.

Butt joints may be put in two classes—one in which one plate is scarfed and the other where both plates are scarfed or beveled in any one of several ways. Both types will be used.

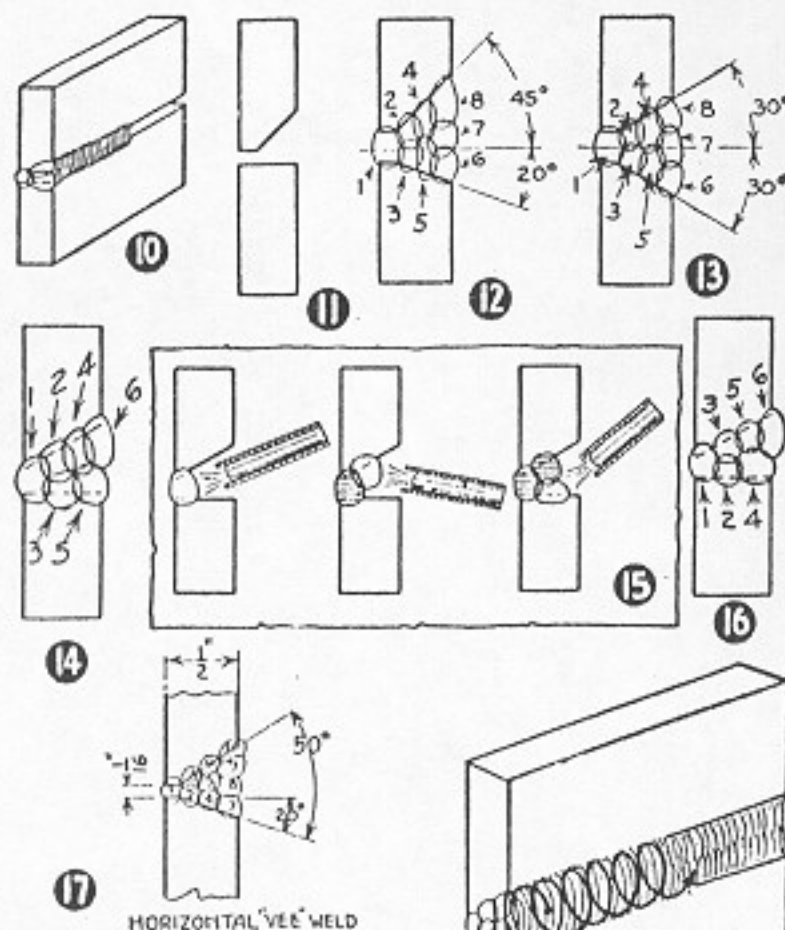
Set two $\frac{1}{4}$ -inch plates in vertical positions as shown in Fig. 10. Make each bead in the sequence shown, using a slight weave. Hold electrode in position similar to Fig. 9. Break apart if possible and examine weld.

Horizontal butt joints are usually scarfed or beveled as shown in Figs. 11, 12, or 13.

The student should practice making each of these kinds of joints.

EXERCISE A. Using plates scarfed as shown in Fig. 8 and a bead sequence as shown in Fig. 14, make a number of horizontal welds.

The electrode should be held about perpendicular to the line of travel (or pointing slightly backward) and at angles as shown in Fig. 15 for various passes. This is necessary to get the



Figs. 10 to 19. Position of base metal, electrode, and beads in horizontal welding of butt joints in vertical position.

Note: Some students may prefer a sequence slightly different than that shown, such as Fig. 16.

EXERCISE B. Make several horizontal welds with joints as shown in Fig. 17. Hold the electrode approximately as shown in Exercise A.

proper fusion of electrode and plate. Some students may prefer a slightly different sequence in which the first bead in each layer is placed on the bottom side. See Fig. 16.

EXERCISE C. Make several joints as shown in Fig. 13. Hold electrode at angle as shown in Exercise A.

It will be noted that in horizontal welding, the beads are usually laid in straight lines without wide weaving; however, for the last pass, the student may find it worth while to practice weaving using the motion such as Fig. 18.

Some welders prefer to weave after the first

three beads are laid as shown in Fig. 19.

Attention is called to the phrase "some people prefer" in the above sentence. This raises the point that arc welding is purely a mechanical operation and after gaining experience, the welder will develop a preference for certain types of weaving due to the fact that they may be most natural to him. This is all right since he can, undoubtedly, do better work if the handling and manipulation of the electrode is done in the most natural way. However, it is important that he always bear in mind the quality and economy of the work he is doing.

Vertical Welding of Lap, Butt, and Tee Joints

LESSON 7

MATERIAL needed for this study includes: steel plates $\frac{1}{4}$ -inch thick; $\frac{5}{32}$ -inch shielded arc type electrodes.

Having become familiar (in Lessons 5 and 6) with flat position welding of lap, tee (or fillet), and butt welds, also with horizontal welding of lap and butt welds, the student is

Fig. 1. Vertical welding of truck body.

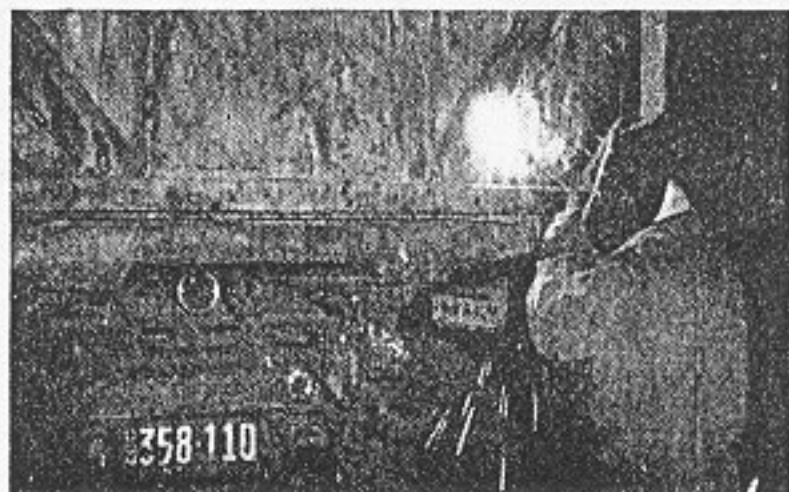


Fig. 2. Vertical welding of end gate on truck.

now ready to consider the subject of vertical welding of lap, butt, and tee welds and gain experience in this new phase of the work by carrying out the instructions in this lesson and practicing sufficiently to handle such work without hesitation. It is not too much to stress again the value of constant practice in the welding methods described in all the lessons in this course.

It should be noted that $\frac{1}{8}$ -inch and $\frac{5}{32}$ -inch "Fleetweld 5" is used for either horizontal, vertical (Figs. 1, 2, and 3) or overhead work. Larger



than $\frac{3}{16}$ -inch is not generally used for vertical or overhead and is not generally recommended although it has been used in some cases.

Welding Down

The best all-around electrode for vertical welding is the $\frac{3}{16}$ -inch. When welding on thin plates or where gaps between plates are small, $\frac{1}{8}$ -inch and $\frac{5}{32}$ -inch may have to be used to prevent burning through on thin gauges and to secure proper penetration on some tight fit ups.

There are two ways to make vertical welds. One is to start at the top and weld downward (called welding down) and the other is to start at the bottom and weld upward (called welding up). With a shielded arc electrode of the type in which the molten metal is generally quite fluid, it is felt that it is usually easier to weld down.

To study vertical welding, set plate in the vertical position. Strike an arc at the top of the plate with the electrode pointing up at an angle of about 60 degrees with the plate (Fig. 4).

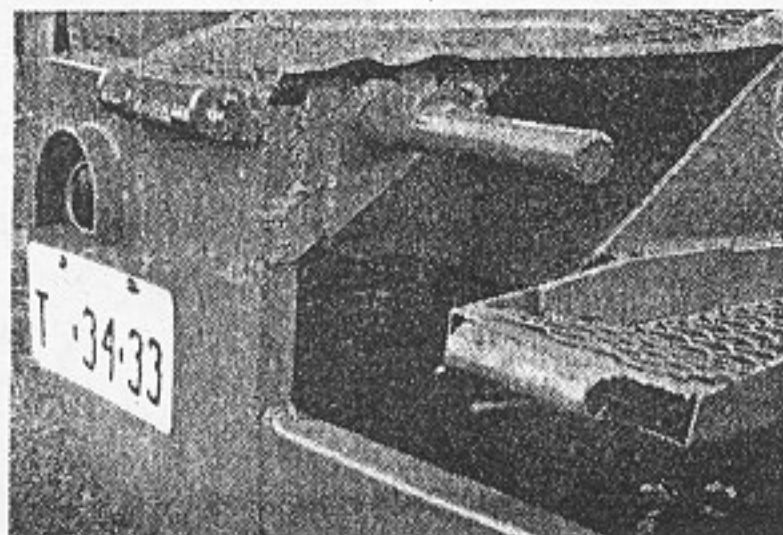


Fig. 3. Vertical welds on bumper of transport trailer.

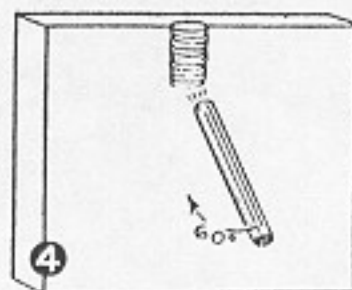


Fig. 4. Practice position for welding down.

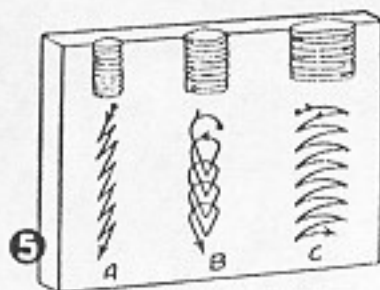


Fig. 5. Weaves to use in welding down.

Draw the electrode down in a straight line. Result will be a thin bead. It is desirable to practice this in maintaining even speed, etc.

Next, repeat the operation, using a slight weave, as shown in A of Fig. 5. This will give a narrow bead but one which is well proportioned. After the student has become proficient in this, he should repeat, using a slightly wider weave, such as B, Fig. 5. Some users find this weave somewhat easier than weave A.

The student should next practice making a much wider bead using a wider weave such as C, Fig. 5. He should practice using all of these weaves until proficient and the motions become second nature.

Vertical Lap and Tee Welds Down

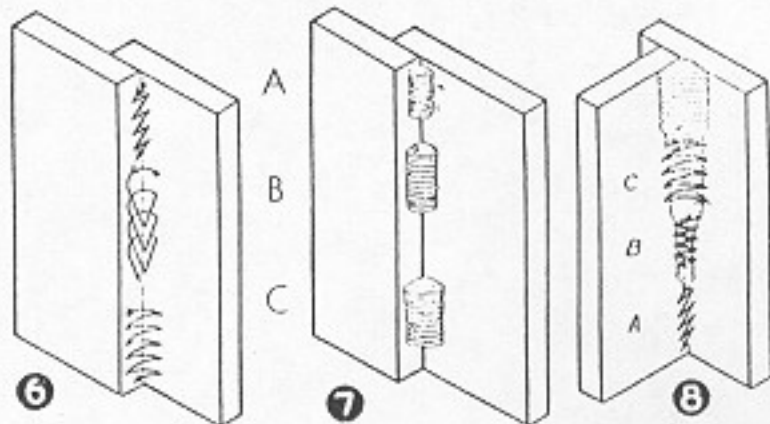
Material needed for this "welding down" study includes: steel plates $\frac{1}{4}$ -inch or $\frac{3}{8}$ -inch thick; $\frac{3}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

It will be noted that lap and fillet welding in vertical position are very similar. The same motions, weaves, etc., being used in both cases.

Tack two plates together to make a lap joint. Place in a vertical position on the welding table. Start at the top, weld down, using weave A, Fig. 6, with the electrode pointing up and at about 45 degrees to the plates in vertical plane (pointing directly into the corner). Travel downward should be at such a rate that a smooth, even, well-shaped bead will be obtained.

Repeat using weave B which will result in a slightly larger bead. Practice until proficient.

Next, the student should repeat the previous exercises, clean the bead well, and then lay a second bead over the first, using the weave shown in C, Fig. 6. The result is shown in Fig. 7. He should frequently break open the plates



Figs. 6, 7, 8. Showing weaves and beads for vertical lap and tee welds.

to make sure he is getting good penetration at the bottom of the weld without porosity—getting solid, homogeneous weld metal.

Repeat the previous exercises except making a fillet or tee weld as shown in Fig. 8. Practice these same exercises using $\frac{3}{16}$ -inch electrodes—particularly the heavy weave C.

The student may wish to practice these exercises using an electrode which gives a rounded bead similar to a bare electrode, it is usually desirable to weld up as with a washed electrode.

The student may wish to practice making vertical welds down with heavier plate. A bead sequence such as shown in Fig. 8 is frequently used.

TABLE A—VERTICAL LAP AND TEE WELDS

Plate Thickness	No. of Passes	Wire Size	Current
$\frac{1}{2}$ " Plate.....	5.....	$\frac{3}{16}$	150

For beads No. 1, 2, 3, 4, use motion A and B, (Fig. 8), and for bead No. 5 use Weave C. Current values are shown in Table A.

If prepared plate is not available, the butt joint may be approximated by tacking two plates together at an angle as shown for downhand welding, Lesson 5, Fig. 13, then welding joint in vertical position.

Vertical Butt Joints Down

Material needed for this "welding down" study includes: steel plates $\frac{1}{4}$ -inch or $\frac{3}{8}$ -inch thick;

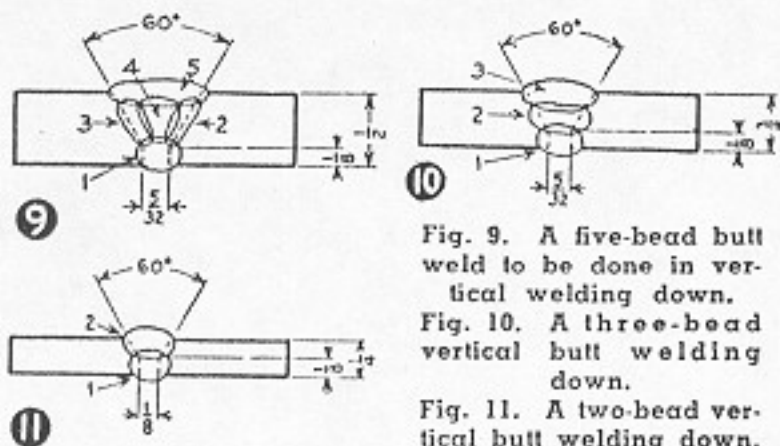
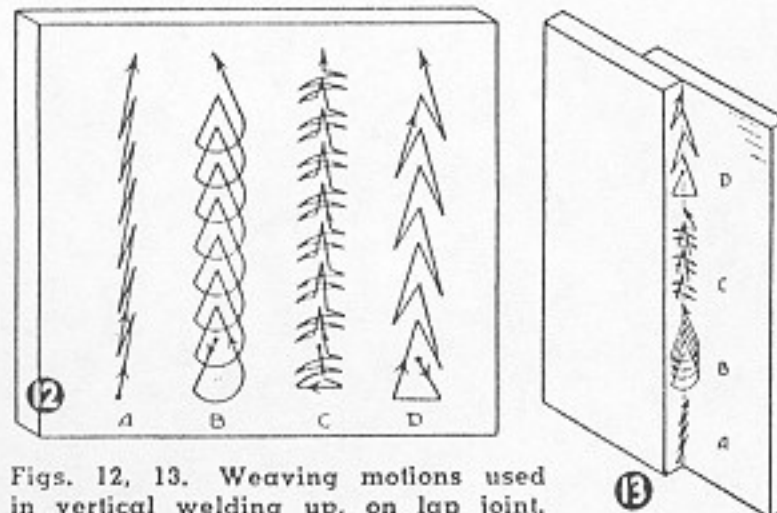


Fig. 9. A five-bead butt weld to be done in vertical welding down.
Fig. 10. A three-bead vertical butt welding down.
Fig. 11. A two-bead vertical butt welding down.

$\frac{1}{8}$ -inch, $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

A review of the various types of butt joints should be made.



Figs. 12, 13. Weaving motions used in vertical welding up, on lap joint.

In general the same weaves are used in making butt joints as for fillet and lap joints.

Set two plates, prepared as in Fig. 11, in a vertical position, tacked together. Start at the top and put in bead No. 1 using weave A, Figs. 6 and 8. Clean the bead thoroughly and again start at the top, putting in bead No. 2, using weave B, Figs. 6 and 8. Use current and electrode sizes as shown in Table B.

TABLE B—VERTICAL BUTT WELDS

Plate Thickness	No. of Passes	Wire Size	Current
$\frac{1}{4}$ " Plate	1	$\frac{1}{8}$	110
	2	$\frac{3}{16}$	150
$\frac{3}{8}$ " Plate	3	$\frac{3}{16}$	150

Set up $\frac{3}{8}$ -inch plate prepared as shown in Fig. 10 in vertical position. Start at top, put in beads No. 1 and No. 2 using motions A and B. Put in bead No. 3, using wider weave such as C, Figs. 6 and 8.

Vertical Welding Up

Material needed for this "welding up" study includes: steel plates $\frac{1}{4}$ -inch thick; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

Set plates in vertical position on the welding tables. Starting at the bottom with $\frac{5}{32}$ -inch electrode, strike the arc and draw the electrode upward in a straight line. Practice until smooth, even motion is obtained.

Next, practice motions A, B, C, and D, Fig. 12. Repeat on each weave until smooth beads are obtained and motion becomes more or less automatic. Repeat this exercise using $\frac{3}{16}$ -inch electrodes.

Vertical Lap and Tee Welds

Material needed for this "welding up" study includes: plates $\frac{1}{4}$ -inch and $\frac{3}{8}$ -inch; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

The making of lap and tee or fillet joints is similar—using approximately the same motions and weaves in each case.

Set up the plates for lap joint in vertical position as shown in Fig. 13. Practice making weld, starting at the bottom and welding up, using weaves A, B, C, and D. Break joints apart to be sure of complete penetration and sound metal. Repeat making complete welds with each weave until proficient.

Repeat these exercises making a fillet weld as shown in Fig.

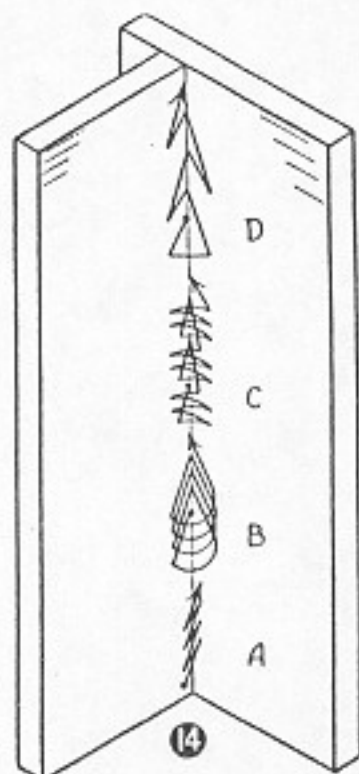


Fig. 14. Vertical welding up on tee joint.

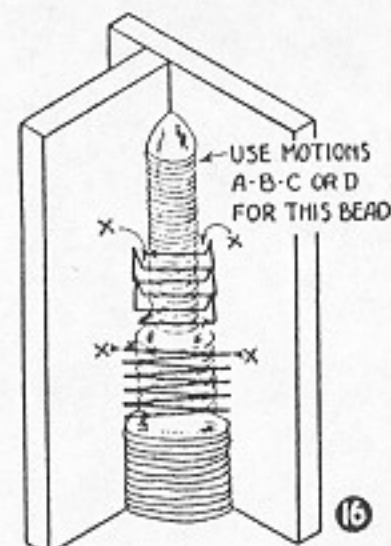
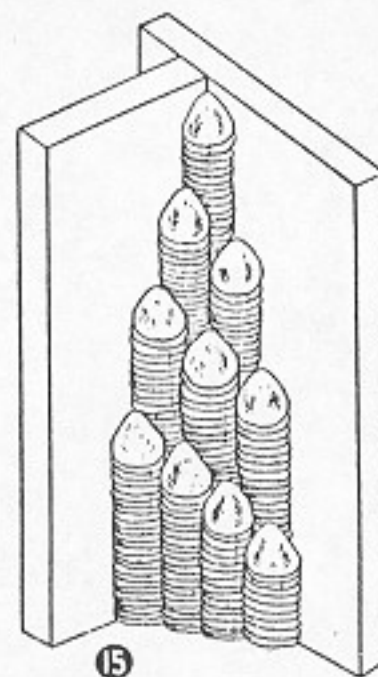


Fig. 15. Multiple beads are used in welding up on heavy fillets.

Fig. 16. Putting in the first, second, and third beads on heavy fillet.

14. Repeat, using $\frac{3}{16}$ -inch electrodes.

In welding up of heavy fillets, or laps there are two general procedures followed. One is to build up the weld by a number of small stringer beads with a motion such as A, B, C, or D. The other consists of using multiple layers of beads which are applied with a wide weaving motion. The student should practice making both types.

The first procedure for heavy fillets, welding up, consists of multiple stringer beads with very little weaving used in any of the beads (Fig. 15).

The student should practice making heavy fillets using this procedure until he is proficient.

Figure 16 illustrates the second method. The first bead should be put in using a slight weaving motion as indicated in the first part of this lesson. The second and third beads should be put in using weave as shown in Fig. 16. Additional beads can be applied, using the weave similar to that shown. In using these weaves, a slight pause should be made at the joints X.

The pause should be somewhat longer for the weave used for the third and fourth beads than for the second bead. These pauses are for the purpose of filling up any undercuts in the plate.

The student should practice making these heavy fillets until proficient.

Vertical Butt Joints

Material needed for this "welding up" study includes: plates $\frac{1}{4}$ -inch and thicker; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

The student should review the types of butt joints. It is not feasible to give detailed instructions covering the welding of all types of butt joints. This lesson covers only the scarfed or vee type. Similar instructions apply to other types.

Set up plates prepared as shown in Fig. 17 in vertical position.

Put in bead No. 1. Start from the bottom using motion similar to A, Figs. 13 and 14. Use $\frac{1}{8}$ -inch or $\frac{5}{32}$ -inch electrode for this bead.

Put in the first bead, welding up, using mo-

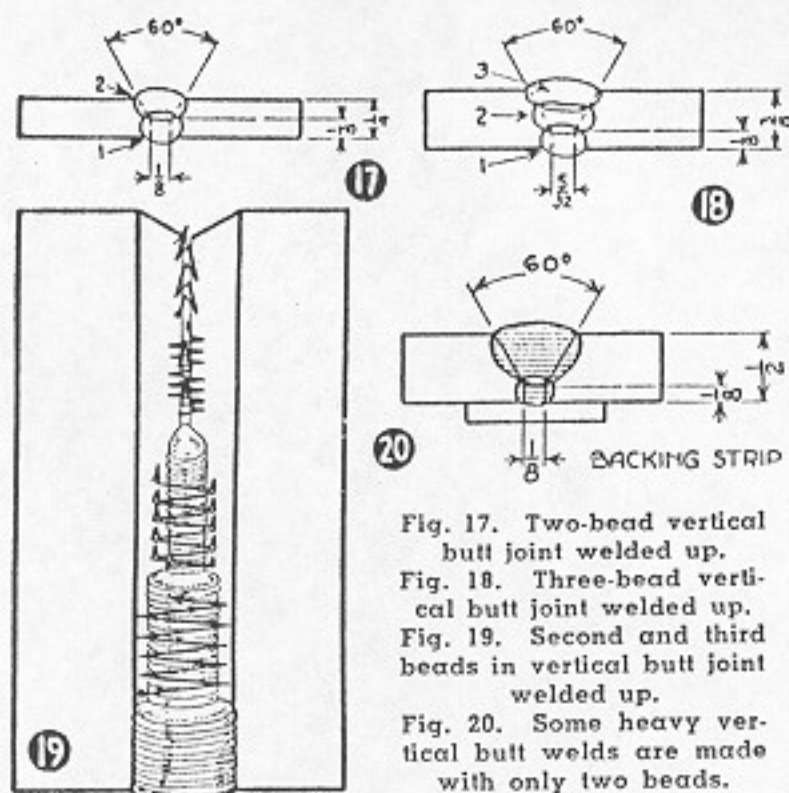


Fig. 17. Two-bead vertical butt joint welded up.

Fig. 18. Three-bead vertical butt joint welded up.

Fig. 19. Second and third beads in vertical butt joint welded up.

Fig. 20. Some heavy vertical butt welds are made with only two beads.

tions B, C, or D, of Figs. 13 and 14. Use sufficient motion to fill in the vee. Use $\frac{3}{16}$ -inch V electrode for this bead.

Set up $\frac{3}{8}$ -inch plates in vertical position (Fig. 18). Weld up, putting in first bead with $\frac{1}{8}$ -inch or $\frac{5}{32}$ -inch electrode, using motion A, Figs. 13 and 14. Put in second and third beads with $\frac{3}{16}$ -inch electrode using carefully the motions that are shown in Fig. 19.

Student should practice until proficient.

Frequently, fairly heavy welds are made in this position with only two beads (Fig. 20).

The student should practice this, putting in the first bead as before, but making the second bead sufficiently heavy to fill out the vee, using a weaving motion like that of the second bead, Fig. 13.

The student will notice, throughout these lessons, frequent use of the word "practice." Practice is very important in learning to weld. Since welding is purely a mechanical operation, the welder should make himself as "handy" as possible in striking the arc, holding the arc the proper length, moving it along the seam to be welded smoothly and uniformly and be able to do all of these things under any conditions whether he be welding in downhand or overhead position.

Overhead Welding of Lap, Fillet and Butt Joints

LESSON 8

MATERIAL needed for this study includes: plates $\frac{3}{16}$ -inch or $\frac{1}{4}$ -inch thick; $\frac{5}{32}$ -inch, $\frac{3}{16}$ -inch shielded arc type electrodes.

Covered in this lesson is the subject of overhead welding (Fig. 1). To the novice this might seem an extremely difficult phase of the work in which to become expert. It is true that overhead welding does require experience and skill. However, the student who has applied himself conscientiously to the work covered in the previous lessons, will have little or no difficulty in mastering welding in overhead position. While he may not be required to do a great deal of this type of work, there will undoubtedly be times when overhead welding will be necessary. It is suggested, therefore, that the student carefully follow the instructions given here and do enough practicing so that he can hold the arc and produce good overhead welds.

Fasten the plates firmly in a horizontal position (Fig. 2) so that the underside may be easily reached with the electrode, and so you can take an easy and comfortable position for welding. Hold the electrode at nearly right angles to the plate. Grasp holder so knuckles of hand are up, palm down, in order that drops of metal will roll off glove and not be caught.

Then practice striking an arc. In doing so,

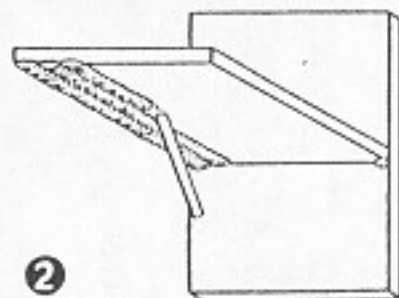


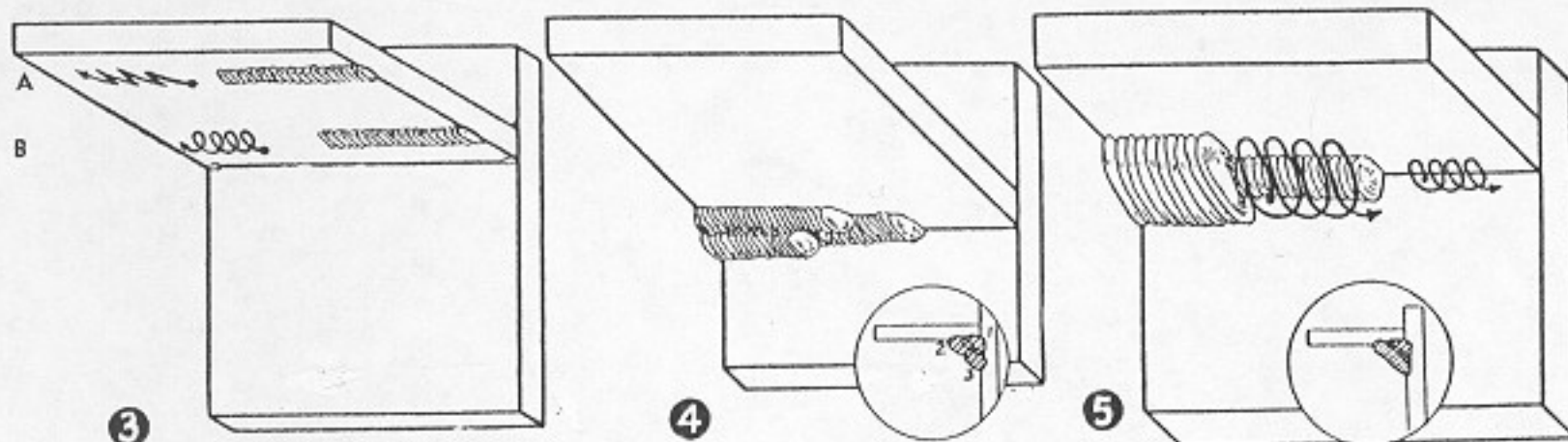
Fig. 2. Plates positioned for overhead welding practice.



Fig. 1. Repair weld on an auto truck frame made in an overhead position.

pause for a short interval with rather a long arc until it is seen that the base metal is molten above the arc. Start by moving the arc away in a straight line. Try this as many times as are necessary for you to strike and maintain the arc. Then, holding a very short arc, and moving the electrode at a steady rate, place a bead on the underside of the plate.

There is of course a tendency for the metal to run down and form drops. A very short arc will stop this. You can melt this drop by using a long arc and, when drop is molten, quickly



Figs. 3, 4, 5. Fillet, or tee, welds in overhead position.

shortening the arc.

This lesson will require a great deal of practice. Try a very short arc, then a short arc and a long arc. Observe the performance of the arc and appearance of bead. Practice until bead looks reasonably good, then inspect it by chipping or filing so that penetration and fusion may be observed. Do not be satisfied with anything except the best bead.

After the student is able to make a satisfactory bead in a straight line, starting and stopping at will, he is ready to start practicing motions such as shown in Fig. 3.

Lap and Fillet Welds in Overhead Position

Material needed for this study includes: plates $\frac{1}{4}$ -inch and $\frac{3}{8}$ -inch thick; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

Fillet and lap welds are made in overhead position in very similar manner. Consequently, this lesson is on fillet welds in detail.

Place two plates tack welded together for a tee weld in overhead position so that the underside may be reached readily with the electrode.

Place a single bead in the corner, using motion A or B of Fig. 3. Repeat until a good, smooth bead is obtained. Break the plates apart frequently to be sure good, full penetration is secured in the corner.

After the student is proficient at making a single bead fillet weld, he should practice making a multiple stringer bead weld, following the general sequence shown in Fig. 4. These beads are also made with motions A or B, as in Fig. 3. Continue until proficient.

After the student has mastered the procedure for stringer beads, he is ready to try multiple beads with weaving. First, make the stringer or corner bead as shown in Fig. 5. After cleaning the bead, lay the second bead, using the weaving motion shown.

After the student has become proficient at making a multiple pass weld as shown, he may wish to make a third bead. This is a rather difficult procedure, but it can be done, using the same weaving motion (except wider weave) as for the second bead. Practice until proficient.

The procedure for making lap welds is almost identical to that for tee or fillet welds. Consequently, the student should practice making lap

welds, of different size or thickness of plate, following the general procedure of fillet welds.

Overhead Butt Welds

Material needed for this study includes: plates $\frac{3}{8}$ -inch thick; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch shielded arc type electrodes.

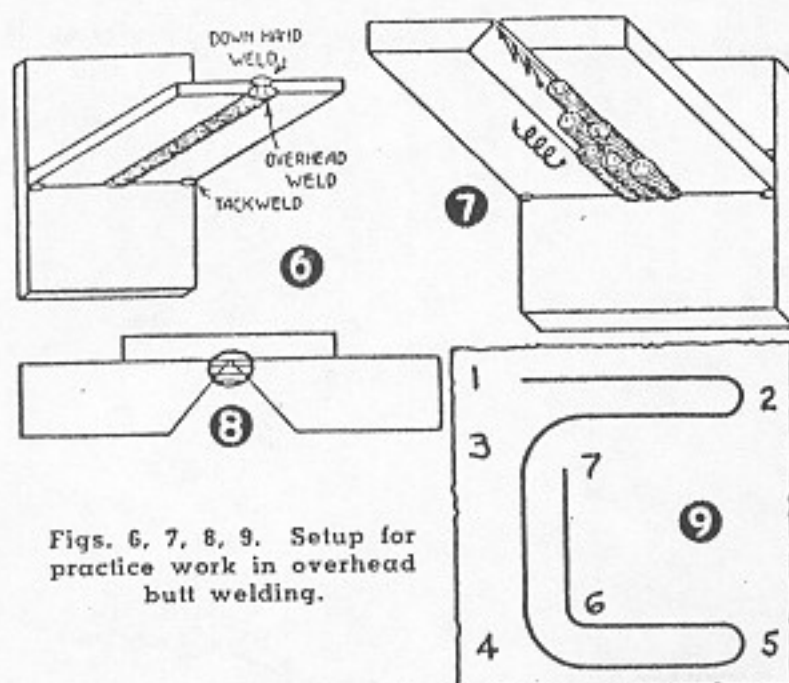
Place two $\frac{1}{4}$ -inch plates with a small opening between their square edges. Tack them and set up for easy access to bottom of joint. With $\frac{5}{32}$ -inch electrode, strike an arc and run a bead along the opening, fusing the two plates together (Fig. 6). Break the plates apart to determine the quality of the metal. For plates up to $\frac{1}{4}$ -inch thickness, a bead can be run on the opposite side for a joint of approximately 100% strength.

Take two heavier plates, scarfed or prepared for a vee butt weld. Place in an overhead position. Following the general procedure shown in Fig. 7, make welds with slight motions shown in Fig. 3. Practice until proficient.

The student may have some difficulty in making the first bead and he will find a backing-up strip will materially assist in making this bead. He should try making it without a backing-up strip because in much construction work it is impossible or impractical to use such a strip (Fig. 8).

In these cases, the plates are usually placed closer together.

The student will find in overhead work, it is usually much easier to make the welds with stringer bead procedure as shown in this lesson.



Figs. 6, 7, 8, 9. Setup for practice work in overhead butt welding.

It is possible to lay succeeding beads in the overhead position using a weave as shown in Fig. 9. This is rather difficult; however, the student may wish to try making a weld using the stringer bead procedure for the first and second layer and the weave of Fig. 9 for the last layer.

Expansion and Contraction in Welding

Material needed for this study includes: two $\frac{1}{8}$ -inch plates 4 inches by 12 inches; two $\frac{1}{4}$ -inch plates 4 inches by 12 inches; $\frac{5}{32}$ -inch and $\frac{3}{16}$ -inch washed electrode and one made expressly for flat welding or an electrode made especially for work where fit up of parts is apt to be poor.

While the subject of expansion and contraction is undoubtedly much more important to the welder engaged in production welding than to the repair welder, some knowledge of the subject will help the student to do better work whether it be in repair of implements and tractors or the fabrication of some piece of equipment for the shop or a customer. Knowing what takes place during welding and being able to take care of the effects of heat in metal parts, the welder will be able to do a better 'all-around' job.

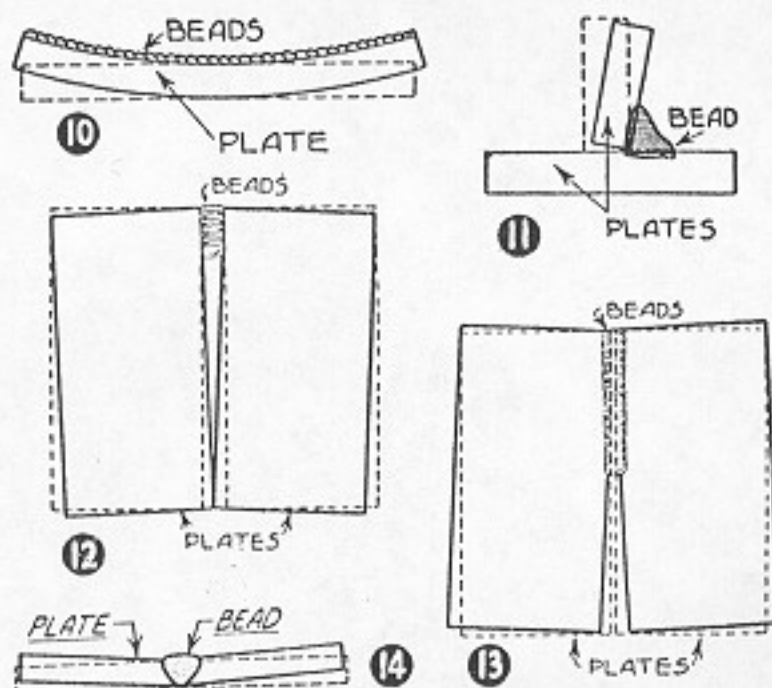
When steel is heated it expands, when cooled it contracts. These rather simple facts are quite frequently overlooked or ignored. It is well, therefore, to get them clearly in mind. A few simple illustrations will be helpful. Suppose a rod of given length is heated throughout its full length to a certain temperature, the rod will expand or increase its length, say .010 inch.

Now if a rod of only half the length is heated to the same temperature as before, the expansion will be .005 inch. If we allow these rods to cool to the same temperature, the contraction of the first will be .010 inch and for the second .005 inch, or approximately equal to the expansion. It may, therefore, be stated that for a given temperature rise (or fall), the expansion (or contraction) depends on the length of the part heated (or cooled).

Suppose the bar is heated to only $\frac{1}{4}$ of the temperature rise, then $\frac{1}{2}$, then $\frac{3}{4}$. The expansion will be .0025 inch, .005 inch, .0075 inch for the longer bar and half this for the shorter bar.

This simple experiment which can be easily carried out, shows that the total expansion depends on the length of metal heated, and on the temperature to which it is heated. Keep these statements in mind. They will be found very helpful in welding problems involving expansion.

When metal cools, it contracts instead of expands, but the same rules govern as for expansion, that is, the contraction depends on the length cooled and the temperature drop. While it is being deposited, weld metal is molten. The edges of the plates being joined are molten, and the plates are hot for some distance back from the joint. When deposited metal and edges of plate, both of which were molten, cool, they contract more for a given length than the other part of the plate because they were hotter.



Figs. 10, 11, 12, 13, 14. Showing expansion and contraction results in arc welding.

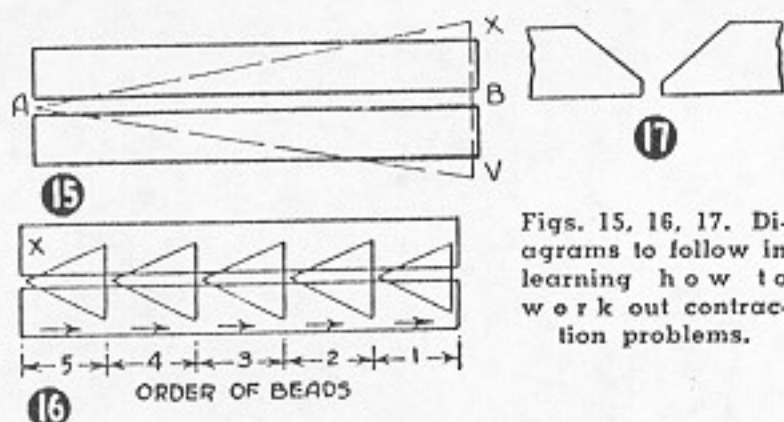
The hot part of the plate does contract and this fact must not be ignored in considering contraction. The various temperature drops and the entire mass of heated metal must both be considered. The problem is evidently very complicated.

For one example, a bead six or eight inches long is deposited on a perfectly flat plate and allowed to cool. As it cools the bead will tend to contract and if the plate is not too thick so that it can bend under the stress imposed and it is free to move, it will curve or bend up in the direction of the bead (Fig. 10).

A bead deposited from a small electrode with low current will cause very little warping due to the relatively small amount of metal which is heated to a high temperature. On the other hand a bead deposited from a large electrode with a high value of current so as to produce nearly complete penetration of the plate will cause very little warping in the direction indicated, due to the fact the metal at the bottom is also heated to a high temperature. There is a welding condition somewhere in between these two extremes that will produce a maximum warping in the direction indicated in Fig. 10.

Another illustration is when two pieces are welded together at right angles with a bead on one side. After the weld has cooled it will be found that the plates are not at right angles and the weld has pulled the pieces toward each other in the direction of the weld, as shown in Fig. 11.

When two plates, with an opening between them, are welded with bare or washed electrode, the plates will draw together as the welding progresses. This is shown in the sketch, Fig. 12. The amount will depend upon the speed of welding. As a usual rule, the greater the speed the less the amount of the drawing effect. There can be found a speed at which the plates will not draw together.



Figs. 15, 16, 17. Diagrams to follow in learning how to work out contraction problems.

When two plates have a tendency to draw together, the expedient of keeping a wedge in the seam 12 inches to 18 inches ahead of the welding proves very satisfactory. Allowance may be made for contraction if possible by separating the plates.

For usual plate thicknesses, the plates should be separated approximately $\frac{1}{8}$ -inch per each lineal foot of weld. The exact amount is difficult to state as it will vary with different jobs and conditions. Experience is the best teacher on this, and the above will serve as a guide.

If the welding speed is further increased as when using shielded arc electrodes, the plates will separate while welding proceeds as indicated in Fig. 13. In this latter case, it will be necessary to tack or clamp the ends together before beginning the welding.

If a plate is vee'd for welding and then welded, it will frequently be found that the plates will be drawn up as shown in the sketch, Fig. 14. This is true since the greater opening is at the top and more molten metal is deposited and a wider zone heated on this side, consequently there is more contraction.

The amount of warping will vary almost directly with the number of passes, being greater for a greater number of passes. This will also

be true of the case shown in Fig. 11. In other words, it is generally advisable to complete the weld with a minimum number of passes.

Take fairly light plates and try the experiment shown in Fig. 10 and Fig. 11 and note the results.

Next try the experiment shown in Fig. 12 using bare or lightly coated electrode such as "Stable-Arc." Repeat this with "Fleetweld 5" at high rate of speed and see if results shown in Fig. 13 can be obtained.

This force is evidently rather large. Refer to Fig. 15. We might represent it as the distance from line AX or AV to AB. If we could break this force up into smaller forces or parts we could reduce its effect.

Refer to Fig. 16. Put in bead 1. The force is not very large. Follow with bead 2 and so on. While there is some force it is not very great, therefore, the distortion is not as great as before. This is the step back method. Note carefully how this is done. The same short beads placed in reverse order (i.e. starting with 5) would be merely interrupted beads and would not give as great a reduction of distortion as the step back method.

Take two plates and weld as in Fig. 17. First, use a great number of small beads. Then repeat but use a few large beads. The plates will move but in the case of the great number of small beads the distortion is more than with the fewer beads. We see, therefore, that we must keep in mind the temperature and the amount of metal heated, that the fewer beads give less distortion than a large number, and that the step back method is very helpful.

These few facts will aid in working out contraction problems. They are not, of course, all the items to be considered. Each job has its own individual problems.

Arc Welding of Cast Iron

LESSON 9

MATERIAL needed for this study includes: some broken pieces of cast iron (may be better to get a scrap casting and break it), and an electrode made expressly for welding cast iron.

The arc welding of cast iron is one of the most important subjects to the welder working in a repair shop. It is important, for one reason, because so many parts to be repaired are made of this metal.

There has always been, and still is, considerable argument as to whether cast iron can be satisfactorily welded. The only answer to this is—cast iron can be and is being successfully arc welded every day (Figs. 2, 3, and 4). The welder who masters the procedure has an almost unlimited opportunity for profitable service to his shop and the shop's customers.

When one part of a gray iron casting is heated that part expands and in so doing may throw

considerable strain on some other part of the casting. This strain, since the metal possesses low ductility and will not stretch, may be suffi-

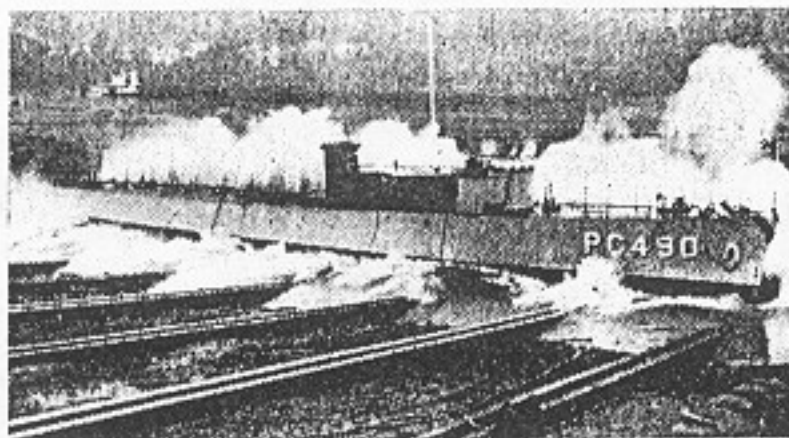


Fig. 1. Arc welding plays a major role in speeding up America's wartime ship building.

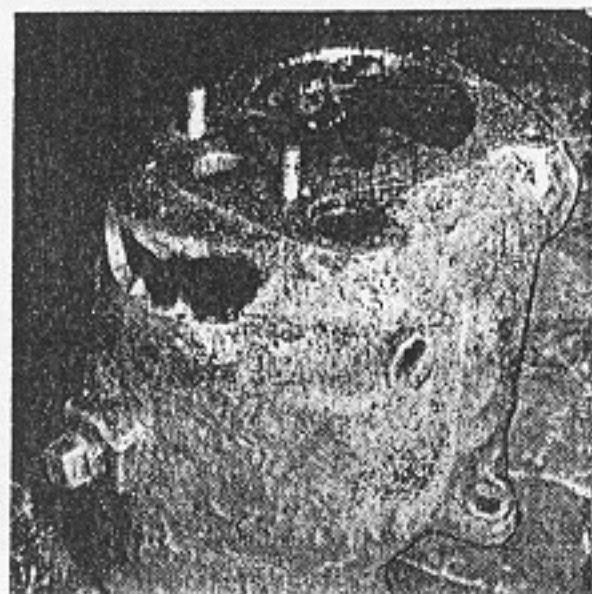


Fig. 2. This broken cast iron transmission case (left) was successfully repaired by arc welding.

Fig. 3. A piece of scrap metal was inserted and arc welding did the rest of the job.



Fig. 5. Expansion and contraction must be equalized at A, B, and C, or the iron casting may break.



Fig. 4. This cast iron starter housing was repaired by arc welding.

cient to break the unheated part. For example, when a casting, such as the one shown in Fig. 5, is heated at A, it will expand at this point and will stress the casting at B and C. It may be stressed beyond its limits and fail at either one of these points or both. Such an occurrence may happen when welding the casting at A, provided parts B and C are not preheated so that the expansion of A, B, and C is equal. In such case the casting will expand and contract alike and cause no undue stress in any part.

When preheating is unnecessary or inadvisable, care should be taken not to heat the casting too long or too much at point of welding at one time, but rather a repetition of "weld little and cool much" until the job is completed.

Each job should be studied carefully before welding in order to avoid possible difficulties arising from uneven expansion and contraction of the casting. The heat of the welding arc is confined to a comparatively small area and for this reason complicated castings offer less trouble when welding is done with the arc than by other methods. It is also for this reason that many gray iron castings can be arc welded in place without dismantling for preheating.

Cast iron welding may be done with a metallic arc using steel electrodes. When using this type of electrode care should be taken in regard to (a) contraction of the weld metal (steel) after deposition, (b) absorption of carbon by the weld metal and rapid cooling which result in hard weld metal.

The shrinkage or contraction of steel from a molten state to a cool state is greater than that

of cast iron, going from a molten state to a cold state. Therefore, when the molten steel from a steel electrode is deposited on cast iron, the steel will shrink more than the cast iron on which it is deposited, causing a residual strain in both the weld metal and the cast iron. A straight bead of weld metal deposited on a horizontal surface of cast iron will be in tension if allowed to cool without further treatment. This is due to the fact that

the steel is trying to contract its length by an amount which is proportionate to its change in temperature. At the same time the cast iron on which the weld metal has been deposited will be stressed due to the pulling action of the weld metal on the cast iron. Since the cast iron is weaker, the usual occurrence (particularly when the bead of weld metal is long) is a break in the cast iron just back of the line of fusion.

It is evident that the greater the length of the weld in a straight length the more strain, since the strain is cumulative. Therefore, if a bead is curved there is a tendency to reduce this cumulative effect (Fig. 6).

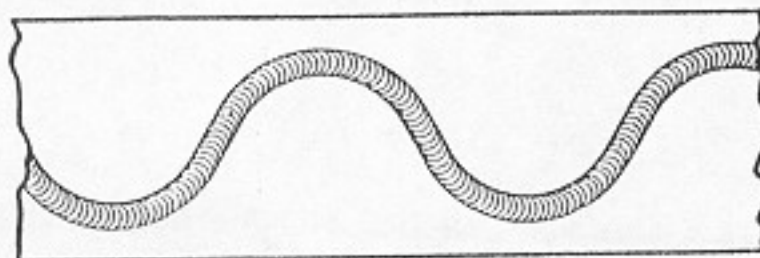


Fig. 6. Cumulative strains on cast iron are relieved by depositing weld metal in curved lines.

Another method is to deposit weld metal in short lengths and allow each to cool. For example, weld one-half minute and then allow weld to cool for three to five minutes. By depositing small welds in various parts of the job one weld is allowed to cool while depositing metal in another location (Fig. 7).

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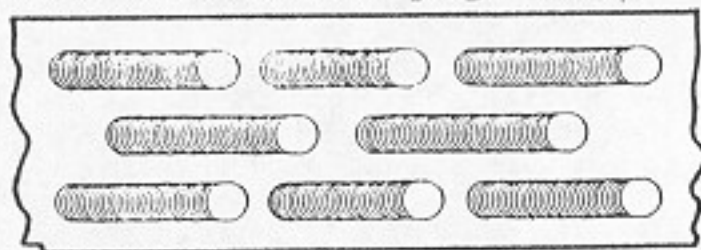


Fig. 7. A sequence of short welds as shown will help to relieve cumulative strains.

The third method is to upset or peen the deposited weld metal lightly while it is still hot, before it has a chance to cool and contract. This causes the weld metal to stretch. In many cases the best method to pursue is to use a combination of the above three methods.

When steel weld metal is deposited on cast iron of large area and the cast iron being cold with the exception of the weld area, the weld metal and the cast iron in its immediate vicinity are cooled quickly. During the process of welding the deposited metal absorbs carbon from the cast iron. Thus the deposited metal becomes high carbon steel, which when cooled quickly is extremely hard. As previously explained, when molten cast iron is cooled quickly its own combined carbon is increased. Therefore, the weld area in the parent metal, when cooled quickly, results in increased hardness of the casting and a tendency to brittleness. Thus in such cases hard, unmachinable material is formed. However, in most repair jobs such a condition presents no difficulties, inasmuch as machining is rarely required. If machining is necessary there are several methods by which the weld metal and weld area in the cast iron can be made machinable; one is to heat the entire casting, or if expansion will cause no difficulty, heat weld and adjacent parts only, to a dark cherry red and allow to cool slowly by covering with asbestos or sand or other heat retention material.

The weld metal deposited by the electric arc process in cast iron is generally far stronger than the cast base metal. When steel electrode is used the weld metal is generally three or four times as strong as the casting.

Coated electrodes of the proper type for welding cast iron are designed to keep the amount of heat required to a minimum, thus reducing thermal disturbance and resultant hardness.

The proper electrode for welding cast iron has a steel base. It provides a solid, dense weld on cast iron of greater tensile strength than the cast iron itself. It affords an excellent bond or union with the cast iron. Because of the low current used, (80 amps. on $\frac{1}{8}$ -inch electrode), the hardening effect usually present along the line of fusion is materially reduced, the resultant weld being, therefore, much more machinable than is usually the case where other electrodes are employed.

Usually $\frac{1}{8}$ -inch size electrodes are used for keeping the heat down as mentioned above. Electrode is made positive, work negative, and current is approximately 80 amperes. This ap-

parently too-low current is employed to satisfy the heat conditions previously mentioned. The electrode itself will carry considerably more current but the requirements of cast iron welding make the use of higher heat inadvisable.

The welding of cast iron should be done very intermittently. In some cases "skip" welding is used with a weld not over three inches made at one time. Immediately after each bead is deposited it should be lightly peened, thoroughly cleaned and allowed to cool before next bead is applied. Care should be taken to keep the work clean and not allow it to get too hot. A good rule is "Keep the work clean and cold."

If the weld area is to be painted, after the weld has cooled, remove the slag from the weld by any convenient mechanical means such as grinding, sand blasting, chipping and wire brushing. Swab the weld and adjacent parent metal with a 10% sulphuric acid solution, preferably warmed to 150-180 degrees F. Allow the acid to act for a few minutes. Rinse off the acid with hot water and at the same time scrub the weld area with a wire brush. Allow to dry before painting.

STUDDING. As explained previously, the chilling action of the cast iron increases the combined carbon and in turn increases the hardness and brittleness, weakening the strength of the cast iron just back of the line of fusion. Welds in cast iron, if of sufficient thickness, may be strengthened by the method of studding.

Studs of steel approximately $\frac{1}{4}$ -inch to $\frac{3}{8}$ -inch diameter should be used. The cast iron should be vee'd and drilled and tapped along the vee so that the studs may be screwed into the casting. The studs should project about $\frac{3}{16}$ -inch to $\frac{1}{4}$ -inch above the cast iron surface. The studs should be long enough to be screwed into the casting to a depth of the diameter of studs.

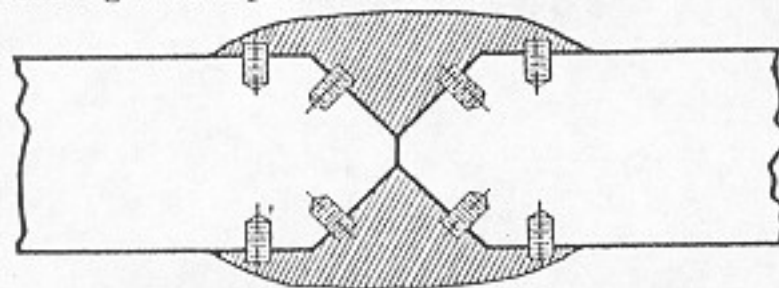


Fig. 8. Casting of sufficient thickness may be vee'd from both sides and then studded.

The cross sectional area of the studs should be about 25% to 35% of the area of the weld surface. In such cases, the strength of the weld may safely and conservatively be taken as the strength of the studs. It is considered good practice to first weld one or two beads around each stud, making sure that fusion is obtained both with the stud and cast iron base metal.

Straight lines of weld metal should be avoided so far as possible. Welds should be deposited intermittently, and each peened before cooling.

It is advisable where the casting is of sufficient thickness to vee from both sides and stud. This should be done as indicated in Fig. 8.

Set up broken casting, matching edges. Tack together or otherwise suitably hold in position. If piece is $\frac{3}{16}$ -inch or over in thickness, vee pieces 45 degrees on each side, total 90 degrees.

Arc Welding of Aluminum

LESSON 10

MATERIAL needed for this study includes: aluminum plates $\frac{1}{8}$ -inch x 3 inches x 5 inches, also several pieces of aluminum casting if available, and $\frac{5}{32}$ -inch electrode made expressly for welding aluminum.

The remarks made frequently in these lessons commenting on the value, to the student, of becoming fully versed in all phases of welding which he may be required to do apply to the arc welding of aluminum for the same reasons that they do to welding various other metals in the different positions. Typical examples are: cylinder heads, crank cases, transport truck tanks, aluminum radiator shells, valve rocker arm covers (Fig. 2), etc. In addition to arc welding aluminum in repair work, the student may also be called upon to fabricate equipment of aluminum for his own shop or for some customer.

The electrode for welding aluminum is a 5% silicon aluminum alloy shielded arc electrode for welding aluminum in any form—cast, sheet, shapes or extruded forms. Designed for either metallic or carbon arc welding, "Aluminweld" opens up a new field for welding, offering a much more economical and less troublesome method of welding than any other process.

The electrode is provided with a coating which prevents excessive oxidation and will dissolve any aluminum oxide which might be formed. The coating also assists in giving a very smooth operating arc which is so particularly essential in welding aluminum. The resulting weld is very dense without porosity and possesses high tensile strength. The weld can be polished satisfactorily with practically no discoloration.

In welding aluminum, the electrode is made positive, work negative.

A short arc should be held, the coating approximately touching the molten pool.

In general, use the highest current possible without melting the edges too far back or burning through. With the high melting rate of aluminum, little heat is dissipated into the plate with consequent chilling of deposits. Hence, it is sometimes desirable to preheat the seam to 600 degrees to 700 degrees F. before welding.

On striking, the best results are obtained by

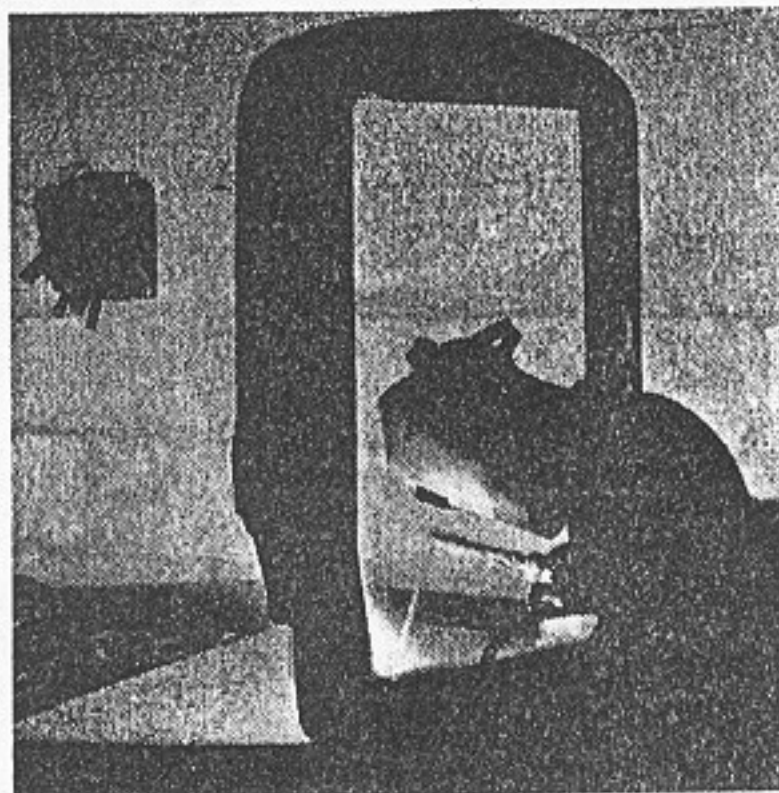


Fig. 1. Repairing an aluminum radiator shell by arc welding.



Fig. 2. Arc welding repairs a break in an aluminum rocker arm cover.

"scratching" the electrode. To start an electrode, strike the arc in the crater, then move the electrode quickly back along the completed weld for $\frac{1}{2}$ inch, then proceed as usual, making sure the crater is completely remelted.

Even melting off of the flux is facilitated by holding the electrode approximately perpendicular to the work at all times.

Always direct arc so that both edges to be welded are properly and uniformly heated and the electrode advanced along the seam at such a rate that a uniform bead is made.

TABLE A—FLAT WELDING

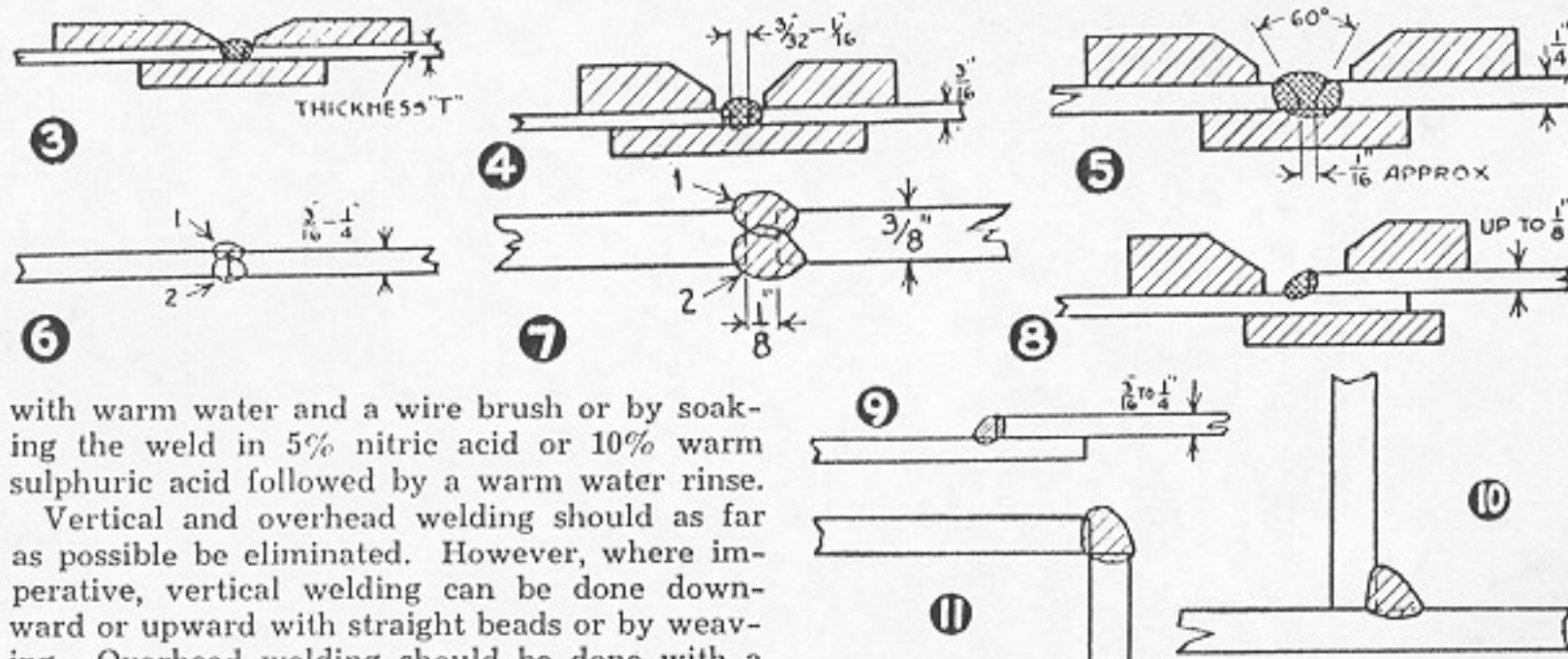
Rod Size	Amperage Range
$\frac{3}{32}$ "	20-55
$\frac{1}{8}$ "	45-125
$\frac{5}{32}$ "	60-170
$\frac{3}{16}$ "	85-235
$\frac{1}{4}$ "	125-360

VERTICAL AND OVERHEAD WELDING

Not recommended. If vertical or overhead welding is required, follow procedure as for flat work, using $\frac{3}{32}$ ", $\frac{1}{8}$ " or $\frac{5}{32}$ " electrode.

TACKING. Increase the recommended currents approximately 50% for tacking. Use short arc and rotary motion.

Remove slag from the weld by light hammering and brushing. Last traces may be removed



with warm water and a wire brush or by soaking the weld in 5% nitric acid or 10% warm sulphuric acid followed by a warm water rinse.

Vertical and overhead welding should as far as possible be eliminated. However, where imperative, vertical welding can be done downward or upward with straight beads or by weaving. Overhead welding should be done with a number of straight beads.

The proper aluminum welding electrode produces excellent welds used as a filler rod with the carbon arc.

BUTT WELDS. The work should be held in position by jigs and backed up by copper, as illustrated in Fig. 3. When butt welding plates $\frac{1}{8}$ -inch and thicker, the copper backing should be slightly grooved beneath the joint to be welded.

Welding of butt joints in $\frac{3}{16}$ -inch plate and heavier should be done with two beads, as indicated in Figs. 6 and 7. No backing or clamping is required for welding joints in this manner.

The general procedure as given previously should be followed in making these types of welds.

TABLE B—BUTT WELDS

Joint	Beads or Passes	Electrode Size	Current Amps.
Fig. 4			
18 ga. sheet	1	$\frac{3}{32}$ "	40
14 ga. sheet	1	$\frac{1}{8}$ "	65
$\frac{1}{8}$ " plate	1	$\frac{5}{32}$ "	120
Fig. 5			
$\frac{3}{16}$ " plate	1	$\frac{3}{16}$ "	170
Fig. 6			
$\frac{1}{4}$ " plate	1	$\frac{1}{4}$ "	250
Fig. 7	1	$\frac{3}{16}$ "	170
$\frac{3}{16}$ " plate	2	$\frac{3}{16}$ "	170
Fig. 7	1	$\frac{3}{16}$ "	170
$\frac{1}{4}$ " plate	2	$\frac{3}{16}$ "	170
Fig. 8	1	$\frac{1}{4}$ "	250
$\frac{3}{8}$ " plate	2	$\frac{1}{4}$ "	250

LAP WELDS. This type of weld should be made in accordance with the general procedure outlined previously, except that the manipulation of the electrode should be in a small rotary motion, playing the arc first on the upper member of the joint and then on the lower member. The electrode should be held in such a position that the angle between the electrode and the horizontal plate is approximately 45 degrees. Plate or sheets of $\frac{1}{8}$ -inch and less in thickness should be clamped in position for welding as indicated in Fig. 8.

TABLE C—LAP WELDS

Joint	Beads or Passes	Electrode Size	Current Amps.
Fig. 9			
14 ga. sheet	1	$\frac{1}{8}$ "	65
$\frac{1}{8}$ " plate	1	$\frac{5}{32}$ "	120
Fig. 10			
$\frac{3}{16}$ " plate	1	$\frac{3}{16}$ "	170
$\frac{1}{4}$ " plate	1	$\frac{1}{4}$ "	250

FILLET WELDS. In making fillet welds the electrode should be held in such a position that the angle between the electrode and the horizontal plate is approximately 45 degrees. The electrode should be manipulated with a small rotary motion with the arc being played first on the vertical member and then on the horizontal member of the joint. With the above exceptions the general procedure given previously should be followed in making a fillet weld.

TABLE D—FILLET WELDS

Joint	Beads or Passes	Electrode Size	Current Amps.
Fig. 11			
$\frac{1}{8}$ " plate	1	$\frac{5}{32}$ "	120
$\frac{3}{16}$ " plate	1	$\frac{3}{16}$ "	170
$\frac{1}{4}$ " plate	1	$\frac{3}{16}$ "	170

CORNER WELDS. This type of weld is made by following the general procedure previously given.

TABLE E—CORNER WELDS

Joint	Beads or Passes	Electrode Size	Current Amps.
Fig. 12			
$\frac{1}{16}$ " plate	1	$\frac{1}{8}$ "	65
$\frac{1}{8}$ " plate	1	$\frac{5}{32}$ "	120
$\frac{3}{16}$ " plate	1	$\frac{3}{16}$ "	170
$\frac{1}{4}$ " plate	1	$\frac{1}{4}$ "	250

Make butt weld in $\frac{1}{8}$ -inch plate, and if material is available repeat with thicker plate. Make lap, fillet and corner welds in light and heavy plate if possible.

THE ability of arc welding to deposit metal of proper quality to replace worn surfaces of machine parts gives the welder an opportunity to take and perform many profitable jobs. With arc weld surfacing the repair man can build up worn shafting of all types of equipment, (Fig. 1) repair scraper blades, dipper teeth (Fig. 3), tractor shoes (Fig. 4), plow shares (Fig. 5), scarifier teeth, and any other metal part subject to wear.

While the surfacing work described here is based on the use of Lincoln electrodes, other makes of electrodes may be utilized so long as they meet requirements for the particular application.

Because of its profit possibilities to the repair shop, arc weld surfacing is covered rather completely in the last two lessons of this course.

The process involves the building up of a layer of metal on a metal surface. The scope and possibilities are almost unlimited and include such varied applications as building up a worn shaft with a low carbon steel deposit, the lining of a carbon steel vessel with a stainless steel corrosion resisting alloy deposit, the deposition of a tool steel cutting edge on a medium carbon steel, or the application of wear resisting surfaces to metal machine parts of all kinds.

The success of a given arc weld surfacing application depends largely on the proper choice of surfacing materials. The choice of surfacing material for a given application is dependent on a number of factors which are outlined below.

1. MATERIAL TO BE SURFACED

- (a) Its composition
- (b) Its physical condition such as hardness, previous heat treatment, etc.

2. DIMENSIONS

- (a) Size and shape of parts
- (b) Size and location of the area to be surfaced
- (c) Thickness of weld deposit

3. FINISH REQUIRED

- (a) As welded
- (b) Machined
- (c) Rough grind
- (d) Fine grind

4. SERVICE CONDITIONS

- (a) Abrasion—its extent and nature
- (b) Impact—its extent and nature
- (c) Corrosion—the corrosive medium

1. Material to Be Surfaced

Composition and Physical Condition. There are thousands of alloy compositions used in parts or equipment that wear or corrode in service. It is obvious that only a few of these can be con-

Surfacing by Arc Welding

LESSON 11

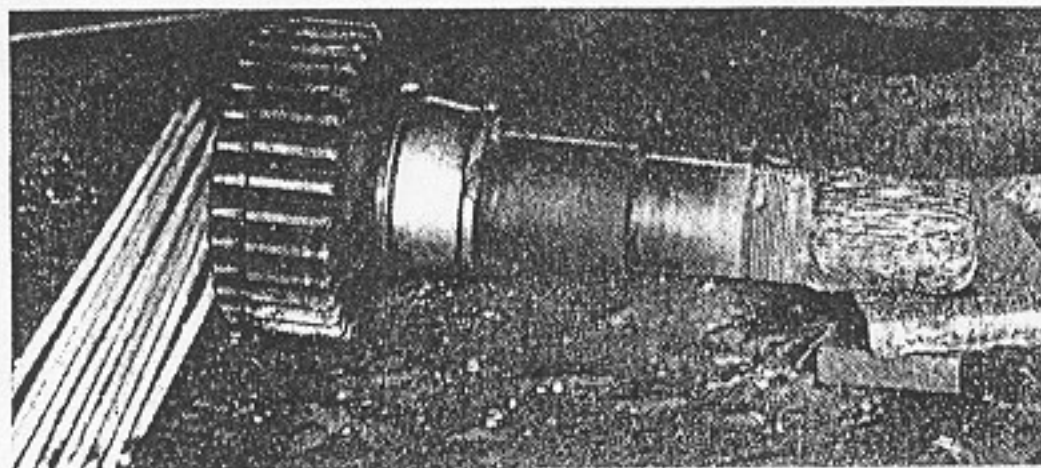


Fig. 1. Arc welding was used to build up damaged threads on part of a truck differential.

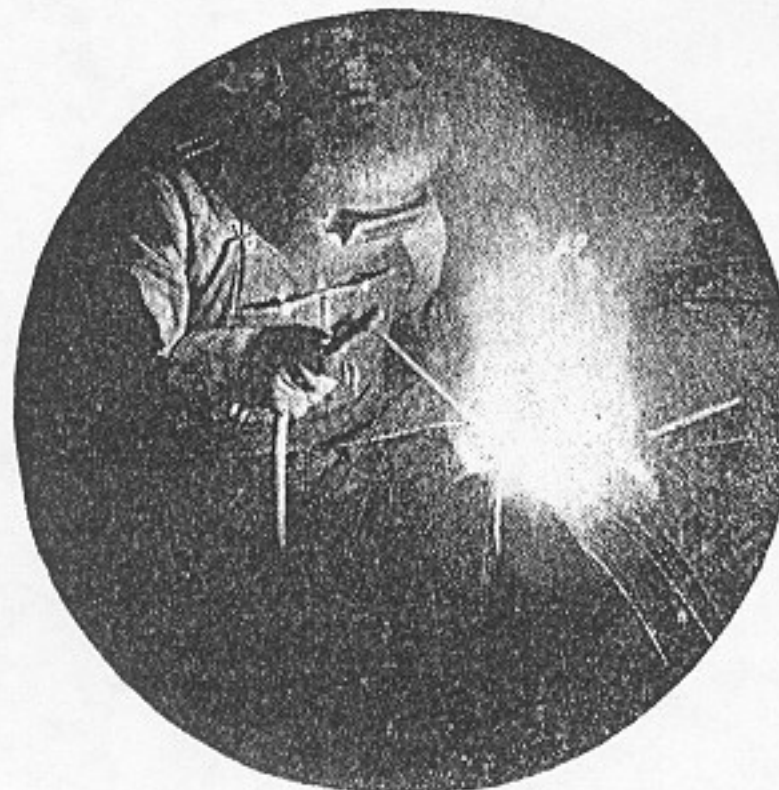


Fig. 2. This two-listed welder is at work on tractor rollers. He is manipulating two electrodes.

sidered in this discussion. Regarding their suitability as a base metal for weld-surfacing, they can be divided into two general groups.

Group A. Those metals or alloys whose physical characteristics are not greatly changed as a result of heating and cooling, and which will withstand sudden localized temperature changes without cracking. This group includes plain carbon steel with .30 carbon maximum, low carbon low alloy steels, austenitic steels such as the stainless chrome-nickel, and the high manganese steels. Copper and most of its alloys would also be included.

Group B. This includes those metals or alloys whose physical characteristics are changed considerably (particularly as to hardness) as a result of the application of welding heat and subsequent cooling, or which will crack with sudden localized application of heat. This group includes medium to high carbon steels, tool steels, me-

dium to high-carbon low-alloy ferritic steels, cast irons; (grey, white, malleable, chilled), semi-steel and, in general, all hard metals and alloys.

In general, metals of Group A may be weld-surfaced without any particular precautions such as preheating, since the thermal cycle incident to the weld-surfacing operation will cause no harmful cracking or hardening adjacent the weld.

Special precautions must be taken in weld-surfacing metals of Group B. In general, if an arc is struck on a metal which is very hard, it will crack due to thermal shock. To avoid or minimize this thermal cracking, we must either reduce the hardness as by annealing or reduce the thermal shock as by gradual and uniform preheating, or both, depending on the nature of the alloy. Thermal cracking can thus be pre-

vented in most steels. In the case of grey cast iron, which is already in its soft condition, but is still brittle, and chilled iron which is hard and very brittle, but cannot be annealed easily, there is little that can be done beyond moderate uniform preheating, which will decrease tendency for thermal cracking. This does not necessarily mean that cast iron should never be weld-surfaced.

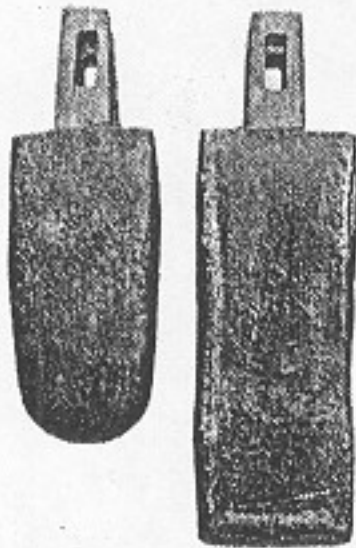


Fig. 3. Before and after pictures of dipper teeth repaired by welding.

The second precaution in connection with weld-surfacing of Group B metals concerns the hardening of the metal adjacent the weld as a result of heating to a high enough temperature to cause solution of free carbides and then cooling fast enough to cause hardening. This may result in subsequent cracking of the hardened area, failure of the part or spalling of the weld deposit. To reduce the tendency to weld-harden, preheating, slow-cooling and post heating, or a combination of these may be employed.

In general, preheating 300 to 500 degrees F. will prevent weld-hardening in medium to high-carbon steels. With medium-carbon alloy steels, preheating as above plus slow cooling as in lime, may be necessary. With high carbon alloy steels such as tool steels and other special wear resisting alloys, preheating followed by reheating after welding to a temperature in the 800 to 1300 degrees range and uniform cooling, may be necessary.

Controlled uniform slow-cooling is always desirable for cast irons to prevent cracking, but their tendency to weld-harden is so great that little can be done to overcome it. When cast iron is weld-surfaced, it is usually a case of build-

ing up a hard wear-resisting surface. Usually the part is made of chilled cast iron. The success of this application depends greatly on the choice of surfacing material. The most successful work is done with a deposit which tends to cross-crack on cooling—such as "Faceweld No. 12." These cross cracks tend to relieve the cooling strains and prevent the weld surface from peeling off in spite of the brittle base metal under the bond.

In most cases where the original chilled iron part was not too brittle for the service conditions involved, the weld-surfaced part will also stand up with the added advantage of a superior abrasion resisting surface. In most cases the cross cracks will not be detrimental. If a strong, tough deposit such as "Abraso-weld" is applied to chilled cast iron, the shrinkage strains will be relieved by cracking under the deposit with the result that the weld-surfacing will break away.

2. Dimensions

(a) Size and Shape of Parts. The heat capacity of the part to be weld-surfaced is largely a function of its size and shape. A part of large heat capacity will heat up slowly during the surfacing operation, reach a relatively low maximum temperature and draw the heat away from the weld area very rapidly. Conversely, a small part or a thin section will heat up rapidly (at least locally), reach a higher maximum temperature and draw the heat away from the weld area very slowly. The mass of the metal being surfaced, therefore, determines to some extent the thermal cycle to which it and the deposit are subjected. For this reason, if local welding heat is applied to a large mass of cold metal which is capable of being quench-hardened, the hardening will be very drastic, and cracking is likely to occur because of steep temperature gradients which result in severe thermal stresses. If the mass is small, the degree of hardening will be less because of its low heat capacity and cooling will be more uniform throughout, resulting in less severe thermal stresses. If the weld-facing material applied in the above examples happens

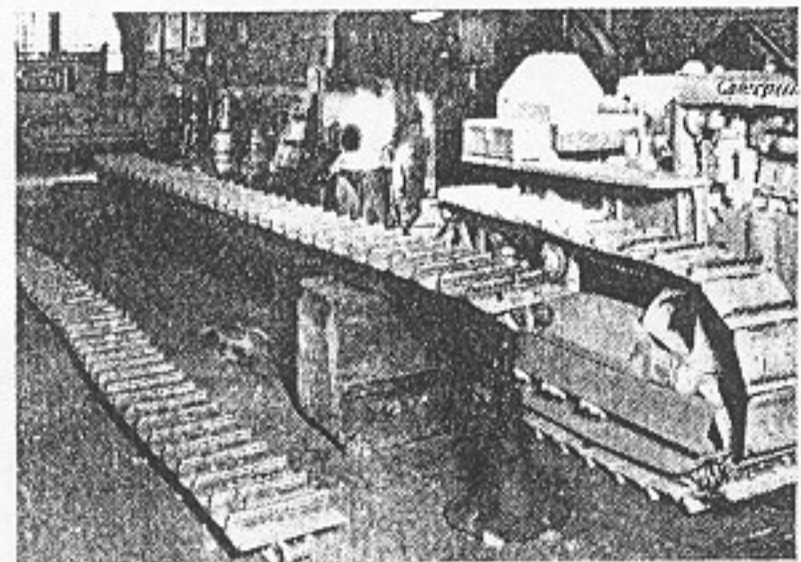


Fig. 4. Arc welding is used to build up badly worn tractor shoes.

to be one of the type whose hardness is affected by the thermal cycle ("Hardweld" for example), the hardness of the deposit will be much greater in the case of the large mass because of its quench effect.

(b) **Size and Location of Area Surfaced.** This will determine the heat input and therefore the thermal cycle as above. Location or position of weld will influence the choice of material to some extent. Very small areas require the use of small electrodes. For various reasons, small electrodes are not available in all types and a second choice must be made. Weld-surfacing material, particularly those intended for hard-facing, are not well adapted for use in vertical and overhead positions. In general, the cost of doing a job will be much lower if the work can be located so that the welding can be done in approximately a flat position.

(c) **Thickness of Weld Deposit.** The best general rule to follow is to avoid thick deposits of the hard alloys. If a large amount of build up is necessary, this should be done with "Fleetweld," "Hardweld 50" or "Hardweld 100." Thick deposits may also be applied with "Stainweld" or "Manganweld."

3. Finish Required

If the weld-surface must be machined, the following deposits can be used in their as-deposited condition.

"Fleetweld," "Shield-Arc 85," "Shield-Arc 100," "Aerisweld," "Stainweld," "Softweld," "Hardweld 50."

The following deposits are not machinable in their as-deposited condition, but are when softened by annealing: "Hardweld 100," "Toolweld 55," "Toolweld 60," "Wearweld" and "Abraso-weld."

"Faceweld" and "Surfaceweld A" deposits must be ground if shaping is necessary.

4. Service Conditions

The various service conditions to which a weld-faced deposit may be subjected can be classified as follows:

1. Abrasion

(a) Grinding action due to rubbing against an abrasive material such as rock, sand, clay or soil.

(b) Sliding, rolling or rubbing action of one metal part against another.

Both (a) and (b) may take place under low or high pressure.

2. Impact

In various degrees from light to heavy. It tends to deform the surface or cause cracking or chipping.

3. Corrosion

This includes the action of various chemicals, ordinary water (rusting) and also oxidation or scaling at elevated temperatures.

It is obvious that before the proper choice of weld-surfacing material can be made for a given

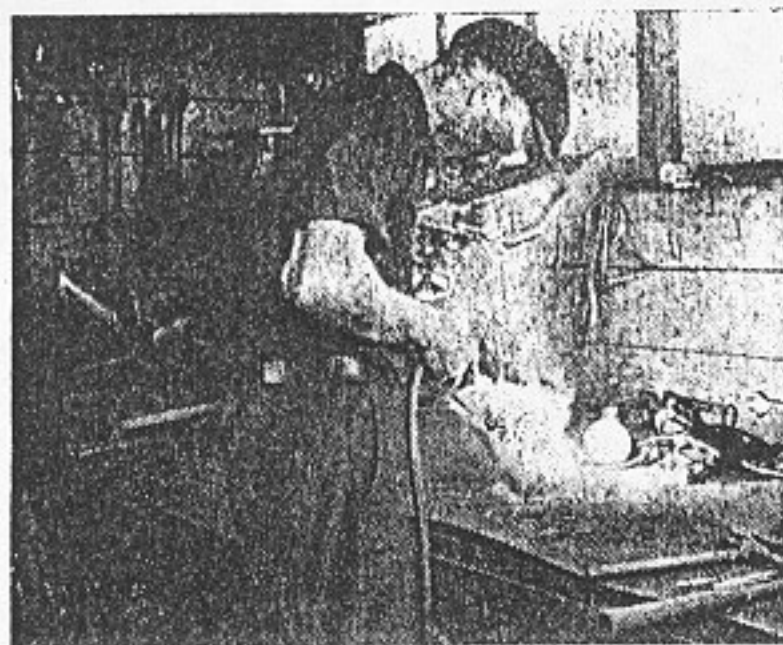


Fig. 5. Worn plow shares can be made like new by welding.

application, the service conditions must be known. In most applications more than one of the above factors are at work and it is then necessary to evaluate the relative importance of each. These factors will be discussed later in connection with Lincoln weld-surfacing electrodes as to their relative abilities to withstand such conditions.

As a matter of convenience in this discussion, the Lincoln line of arc weld-surfacing materials can be divided into three groups, according to the type of deposit they produce. The mild steel and high tensile low alloy steel deposits will not be included here, as their properties are well known.

Martensitic Type

Listed in their order of increasing hardness: "Hardweld 50," "Hardweld 100," "Wearweld," "Toolweld 55," and "Toolweld 60."

Deposits of this group show practically their full hardness in the as-deposited state—that is, they show a relatively small increase in hardness on cold working. They are heat-treatable straight carbon or alloy steels and may be annealed to reduce hardness, and quenched from above their critical temperatures to harden. For this reason, the deposit hardness may also vary somewhat because of variable welding thermal cycles. Of these the "Toolweld" deposits are the highest in alloy content and the most stable in hardness variation. In general, the higher the hardness of the deposit in this group, the better the resistance to wear and deformation and the lower the resistance to impact or chipping.

Austenitic Type

"Stainweld," "Manganweld," "Abraso-weld."

Austenitic deposits differ from the Martensitic principally in that they possess the property of hardening at the surface when deformation takes place as in peening or cold working—the rest of the deposit remaining relatively soft and tough.

"Stainweld," "Manganweld" and "Abraso-weld" differ principally in their capacity for work-

hardening. "Abrasoweld" has the highest initial hardness of this group, work-hardens very rapidly and to the greatest degree with the least amount of cold-working. "Stainweld," on the other hand, is the softest of the group as deposited and shows the least capacity for work-hardening. However, the amount of work-hardening in a "Stainweld" deposit is much more than is generally realized and this, together with its exceptionally high degree of toughness and resistance to corrosion makes it a very useful electrode for many arc weld-surfacing applications.

Carbide Type

"Faceweld No. 1," "Surfaceweld A" "Faceweld No. 12."

These are primarily abrasion resisting materials, high in carbides of such metals as Tungsten, Chromium, Vanadium and Molybdenum. They are inherently hard and respond little or not at all to heat treatment.

Carbide types may be conveniently divided into two groups as represented by:

- (a) "Surfaceweld," which is a mixture of powdered alloys and fluxing ingredients. A carbon arc is used to melt these alloys to form a layer of the carbide type deposit right in place during the arc-surfacing

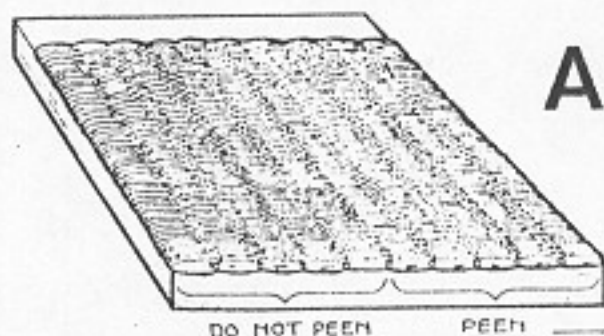


Fig. 1. In learning to surface lay a pad of beads as shown here. Peen half of the welded plate.

MATERIAL needed for this study includes: plates $\frac{1}{4}$ -inch x 3-inch x 5-inch mild steel; $\frac{5}{32}$ " "Stainweld A-5" or "Stainweld A-7" electrode.

"Stainweld A-5" is a shielded arc electrode for welding stainless steels of the 18% chromium, 8% nickel variety in flat, vertical and overhead positions. These steels of Iron & Steel Institute Type Nos. X304, X306, 321 and 347 include Allegheny Metal, Enduro KA2, Resistal KA2, Uniloy Duraloy 18-8, Sterling Nirosta, U.S.S. 18-8 Bethadur No. 2, Nevastain, Colonial Stainless N, and the recently developed "stainless clad" steels. It is also used extensively for providing protective overlay to many types of steel and for welding high manganese steel where strength is paramount.

"Stainweld A-7" is a shielded arc electrode for welding steels similar to A-5 except there is no Columbium contained in deposit and in general the bead will be convex or built up. In

TABLE A

ABRASION		IMPACT	CORROSION*
GRINDING ACTION	METALLIC FRICTION	LIGHT OR HEAVY	CHEMICAL OR ATMOSPHERIC
Faceweld No. 12 Surfaceweld A Faceweld No. 1 Abrassoweld Manganweld Stainweld A Toolweld 60 Toolweld 55 Wearweld Hardweld 100 Hardweld 50	Faceweld No. 12 Surfaceweld A Faceweld No. 1 Toolweld 60 Toolweld 55 Abrassoweld Wearweld Manganweld Stainweld A Hardweld 100 Hardweld 50	Stainweld A Manganweld Hardweld 50 Hardweld 100 Abrassoweld Wearweld Toolweld 55 Toolweld 60 Faceweld No. 1 Surfaceweld A Faceweld No. 12	Stainweld A Faceweld No. 12 Faceweld No. 1 Surfaceweld A Abrassoweld Toolweld 55 Toolweld 60 Wearweld Manganweld Hardweld 50 Hardweld 100

Note: For metal cutting edges, the only proper electrodes are: "Toolweld 60" and "Toolweld 55."

* Special corroding media may change the order of this list.

operation. Very thin deposits are possible with this material.

- (b) "Faceweld No. 1" and "Faceweld No. 12," which are cast into rod form and coated, and are applied by the metallic arc process.

Table A will be helpful in choosing the proper arc weld-surfacing material for a given job. The deposits are listed in their order of ability to withstand the various types of service—the first in the list being the best in each case.

Above table gives a complete list of Lincoln electrodes for every surfacing application.

Arc Weld Surfacing With Various Electrodes

LESSON 12

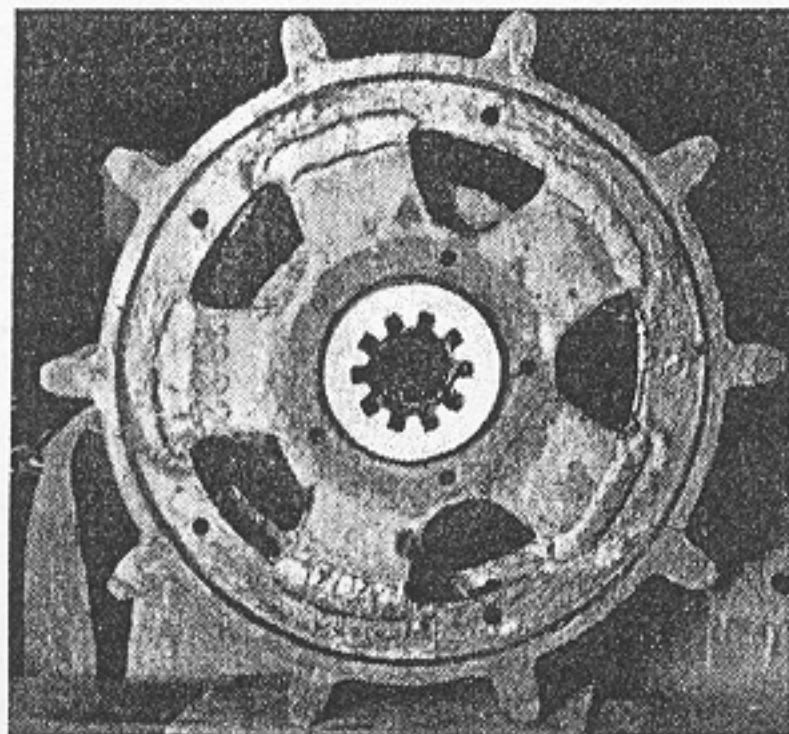


Fig. 2. Worn teeth were built up and each broken spoke of this manganese steel sprocket wheel for a tractor were repaired by arc welding.

general, use the same instructions as given for A-5 except slightly higher current may be used, (5%-10% higher). Tensile strength is slightly less and elongation slightly higher, (approximately 5%-10%).

The first step in learning to surface is to lay a pad of longitudinal beads on the plate as shown in Fig. 1. Clean the plate carefully after each bead is laid.

Upon completionpeen half of the plate.

Then by means of chisel and hammer note the difference in hardness between peened and unpeened sections. The chisel will cause some work hardening so care must be exercised in doing this. Don't get the tests too close together in making comparisons on the unpeened part. If a hardness testing machine is available, actually test hardness and compare.

A manganese steel sprocket wheel, teeth of which were built up with "Stainweld," is shown in Fig. 2.

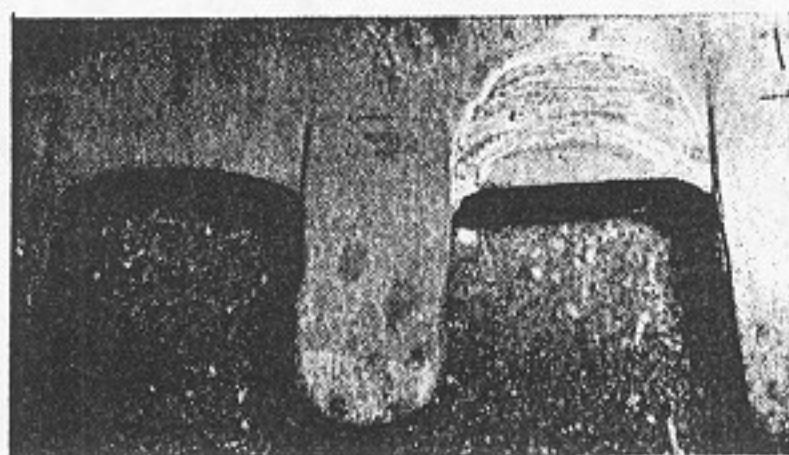
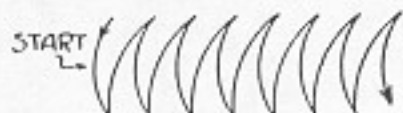


Fig. 3. Dragline bucket lip was rebuilt by arc welding process.

Fig. 4. Weave to use for making an abrasion-resisting surface on high manganese steel.



"Manganweld A" Electrode

Material needed for this study includes: part of an old crossover or dipper tooth or any high manganese casting; 5/32-inch "Manganweld A" electrode.

"Manganweld A" is a shielded arc electrode for reclaiming worn austenitic manganese steel parts (Fig. 3), containing 11% to 14% manganese. It is generally recommended for flat work only.

Typical applications of "Manganweld A" electrode include: dipper teeth, dipper lips, shovel drive sprockets, shovel tracks, crusher pads, crusher hammers, chain hooks, manganese buckets, crusher rolls, crusher screens, drag-line pins and links, cement grinder rings, dredge parts.

In general, "Manganweld A" will give flatter bead than "Manganweld B." It melts uniformly with minimum spatter and boiling in crater. Deposit is air-toughening, remaining in austenitic state and retaining carbides in solution even on air cooling. Abrasion and impact resistance equal to heat-treated cast manganese steel. As de-

posited, hardness 5 to 10 Rockwell C. Cold-worked hardness 45 to 50 Rockwell C.

In welding with "Manganweld A" make the electrode positive, work negative.

Use "Manganweld A" for resurfacing and building up high manganese steel. For welding up cracks in high manganese steel, for welding parts of high manganese steel together, or for welding a part to mild rolled steel, use "Stainweld A." Then if an abrasion-resisting surface is required, apply top beads with "Manganweld A," using weave shown in Fig. 4.

First remove all rust, grease, spongy or defective metal from work. Use lowest heat possible. Allow work to cool between beads.

Wherever possible deposit in pads 1/2-inch to 1-inch wide, preferably not more than 3 inches long. Avoid long, narrow beads.

Allow to cool somewhat between beads. Precaution should be taken to avoid localized heating of manganese steel castings. Beads should be so placed that the heat is well distributed. If necessary, the work, (not the weld), should be cooled with water periodically to prevent distortion and possible cracking of the casting. Hammer surface of bead immediately while cooling, to compensate for shrinkage.

Clean off all slag and brush area where next bead is to be deposited.

Should not be quenched. It will form a tough deposit when allowed to cool naturally.

Not generally recommended for vertical or overhead welding. However, if such work is attempted, use lower current settings given for flat work.

TABLE A—FLAT

Rod Size	Amperage Range
5/32"	90-130
3/16"	130-170
7/32"	150-200
1/4"	170-225

"Manganweld B" electrode is also available for arc welding manganese steel. It differs from "Manganweld A" in that it is a bare rod instead of coated.

"Hardweld 100" Electrode

Material needed for this study includes: several plates 3-inch x 5-inch approximately. At least one of these should be high carbon .60% to .80%; 5/32-inch "Hardweld 100" electrode.

"Hardweld 100" is a light-coated, high-carbon electrode for building up worn steel parts to produce a dense, tough surface of moderate hardness to resist shock and abrasion.

Typical applications of "Hardweld 100" electrode include: pump housings, tractor grousers, shafts, well drilling tools, pulverizer hammers, crusher rolls, gear teeth and punches.

This electrode is light coated and fast flowing. It contains approximately 1.00% carbon. Hardness of deposit on straight carbon steel when allowed to cool naturally: 20 to 45 Rockwell C. Exact hardness depends on rate of cooling and carbon content of steel welded. It cannot be

machined unless cooled very slowly or annealed. Grind to shape, if shaping is necessary.

In welding with "Hardweld 100" make the electrode positive, work negative.

Deposit wide or narrow beads as desired. Brush each bead before depositing next. Peening the completed bead will harden the deposit somewhat. Quenching in cold water will increase surface hardness.

Can be used for vertical welding, but for best results work should be as near flat as possible. Where vertical welding is required, start at bottom and weld up. Not recommended for overhead welding.

Make a sample on low carbon plate by making several parallel beads.

Now make a deposit similarly on high carbon plate. Check again. Try quenching in water. Check again.

Run several beads one on top of the other. Clean each bead. Check after each bead. Note hardness and toughness of deposit.

TABLE B—FLAT

Rod Size	Amperage Range
1/8"	70-110
5/32"	100-150
3/16"	150-225
1/4"	225-350

"Hardweld 50" Electrode

Material needed for this study includes: several plates 3-inch x 5-inch approximately. At least one of these should be medium carbon (.40 to .60); 5/32-inch "Hardweld 50" electrodes.

"Hardweld 50" is a light coated electrode of reversed polarity type for building up dense, tough medium carbon deposits that resist deformation and wear and which are machinable at slow speed. It is also used for building up worn parts to size prior to application of harder facing alloys.

Typical applications of "Hardweld 50" electrode include: sprockets, crane wheels, tractor shoes, tractor rollers, wobblers, dredging spuds, mixer

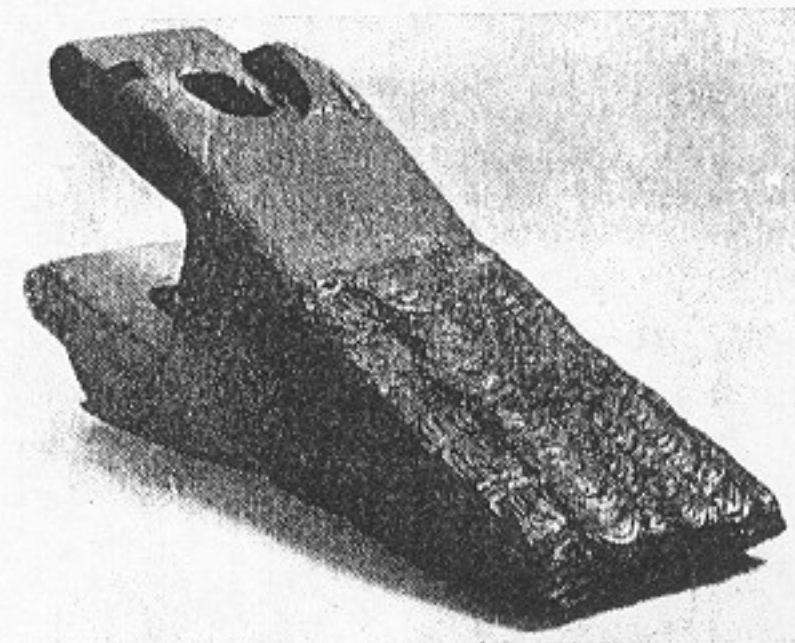


Fig. 5. Dipper tooth for a power shovel was built up by use of special electrodes for manganese steel work.

blades, trip dogs and other similar parts.

On straight carbon steel and allowed to cool naturally, hardness is 20 to 35 Rockwell C. Deposit may be further hardened by water quenching from approximately 1500 degrees F. or by flame hardening.

Procedure is essentially the same as for "Hardweld 100."

Make a sample on low carbon plate by making several parallel beads. Check it for hardness by striking with hammer or punch.

Now make deposit similarly on high carbon plate. Check again. Try quenching in water. Check again.

Run several beads one on top of the other. Clean each bead. Check after each bead. Note hardness and toughness of deposit.

"Abrasoweld" Electrode

Material needed for this study includes: plates 1/4-inch x 3-inch x 5-inch; 3/16-inch "Abrasoweld."

"Abrasoweld" is a shielded arc electrode for building up straight carbon steel, low-alloy or

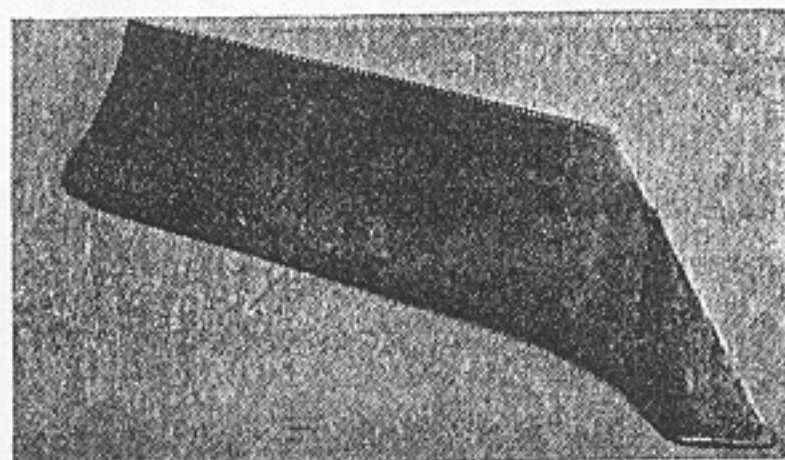
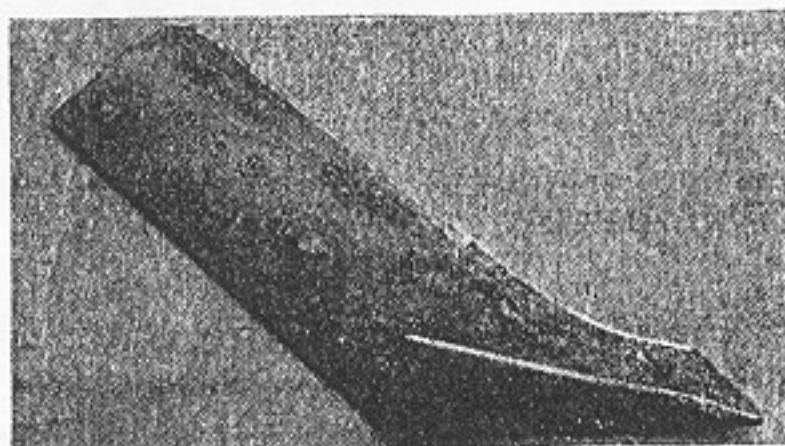
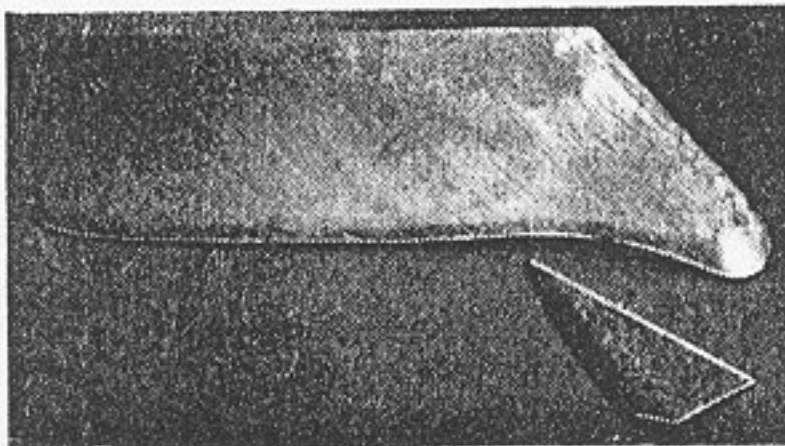


Fig. 6. Repairs on a broken plow share. Middle: New point welded on and point and edge surfaced. Bottom: Finished share after forging.

high manganese steel with a self-hardening deposit to resist severe abrasion, pronounced battering and impact.

Typical applications of "Abradoweld" electrode include: dipper teeth (Fig. 5), tractor grousers, shovel tracks, shovel drive sprockets, dipper lips, dredge cutter teeth, scraper blades, screw flights, plow shares (Fig. 6), scarifier teeth, truck chains, pump housings, conveyor buckets, conveyor rolls, gears, pulverizer plows.

The electrode deposits a semi-austenitic abrasion-resisting alloy of the self-hardening type, which hardens very rapidly under conditions of impact and abrasion. For example, moderate peening will increase hardness as deposited from 20-30 Rockwell C to approximately 50 Rockwell C. It maintains its toughness and develops its maximum hardness only at the surface where it is cold worked. Thus at all times beneath the surface remains a cushion of softer metal which eliminates checking and flaking so common with abrasion-resisting metal produced by ordinary electrodes. Deposit is more resistant to corrosion than high manganese steel. It can be forged hot without materially altering its physical properties.

In welding with "Abradoweld" make the electrode positive, work negative.

Hold fairly close arc but do not allow coating to touch the molten metal.

In general, avoid thick multi-layer deposits.

For straight carbon steel or low-alloy steel, build up largely with "Hardweld" and finish with about two layers of "Abradoweld." In applications requiring a thicker deposit, apply layer of "Stainweld A" electrode and balance with "Abradoweld," peening each layer as deposited.

In high manganese steel, build up part way with "Manganweld" or use "Abradoweld" entirely as desired. In either case, peen each layer as deposited to relieve cooling stresses.

"Abradoweld" deposits must be ground to shape, as they cannot be filed or machined.

In applying "Abradoweld" electrode, best results are obtained by weaving beads about $\frac{3}{4}$ -inch wide.

TABLE C

Rod Size	Amperage Range
1/8"	75-130
5/32"	100-165
3/16"	125-200
1/4"	175-320

Lay several parallel beads, grind smooth, and test for hardness. Peen the deposits well, and then test for hardness, again. Note how peening has increased hardness.

Now add additional layer on top of previous deposits. Grind and test for hardness. Peen well, grind and again test for hardness.

Make pad using "Hardweld 50" or "Hardweld 100." Clean well, then add layer of "Abradoweld." Test for hardness, peen and again test for hardness. Repeat using "Stainweld A" for first pad.



Fig. 7. This dragline "crowfoot" was built up at worn parts at a cost of \$4.50.

In conclusion, it is believed important to point out other applications of arc welding which students may, at one time or another, have occasion to do. Such possibilities might be the welding of special metals such as high tensile steel, stainless steel, chromium steel, chrome moly steel, bronze, brass and copper, and the use of hard-facing with "Wearweld" for building up worn steel parts to resist rolling and sliding abrasion, with "Toolweld" electrodes for making metal cutting edges, with "Faceweld" for hard-facing worn parts to resist severe abrasion and moderate impact, and "Surfaceweld" for hard-facing to resist abrasion.

There are a considerable number of factors which affect the most efficient use of electrodes. If conscientiously controlled, these factors will assure the best results in welding. The factors are: (1) selection of the right type of joint and fit-up; (2) choice of the correct type of electrode; (3) use of an electrode which maintains a uniform coating; (4) use of electrodes which provide proper physical properties; (5) use of fast flowing electrodes wherever possible; (6) selection of an electrode which keeps splatter and slag loss at a minimum; (7) use of electrodes wherever possible which produce flat beads; (8) right size electrode; (9) use of long electrodes in the larger size; (10) care not to bend electrodes; (11) use of proper voltage and current settings; and (12) adherence to procedure specified for the electrode.

In this series of lessons, an attempt has been made to give the reader the type of instruction which he will find most frequently useful in connection with his work. Having completed the series, with sufficient practice applied to each lesson, the student will have obtained the fundamentals from which he can go ahead and become entirely expert as a welder.

GENERAL METAL

Principles, Procedures, and Projects

ROLAND R. FRASER

PRINCIPAL, GEORGE WASHINGTON TRADE SCHOOL
DETROIT PUBLIC SCHOOLS

EARL L. BEDELL

DIVISIONAL DIRECTOR, VOCATIONAL EDUCATION
DETROIT PUBLIC SCHOOLS

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A WORD TO THE INSTRUCTOR

This book has been carefully organized to help solve the many problems that confront you. These problems include providing vocational guidance (with emphasis on the social and economic implications of your course) as well as giving the student the opportunity to develop manipulative skill and acquire technical knowledge.

A modern industrial arts course in general metal should contribute to the goals of education in terms of ideals, attitudes, appreciations, and skills. Therefore the content of this book was selected with the following objectives in mind:

1. To develop an interest in and an understanding of the place of the metals industries in the social and economic life of the community.
2. To develop consumer knowledge, which involves the ability to select various products wisely, care for them properly, and use them efficiently.
3. To develop safe work habits and respect for healthful working conditions.
4. To foster appreciation of good design, good material, and good workmanship in the creation of articles of beauty and usefulness.
5. To provide opportunities for developing independent planning and following through a job to successful completion.

As a teacher you are aware that lack of reading ability is a major obstacle to the success of some students. For this reason an effort has been made to use words, sentences, and explanations that are within the reading ability of the average student.

The tools used in metal working are discussed in relation to the operations performed with them. For example, Chapter 4 is devoted to measuring and layout instruments, while Chapter 6 deals with cutting and filing. The use

of tools in enameling on copper, metal tooling, metal spinning, molding, bench work, art metal work, sheet metal work, and ornamental iron work, and the operation of the grinder, power hack saw, drill press, lathe, shaper, and milling machine are explained and illustrated with the same relationship in mind.

A list of questions appears at the end of each chapter as a review of the topics covered. In addition, projects are suggested for each of the areas of

instruction. With each project is a partial list of the operations to be used in its construction, with references to the text for the necessary information about the materials and tools. These suggestions will serve as a guide for the student in doing his own planning.

In these ways, we believe, the book can be a valuable help in the conduct of your course.

THE AUTHORS

A MESSAGE TO THE STUDENT

This is an age of metal. In almost every activity of our lives we use metal articles, which in turn were made by metal machines. Many new metals are in common use these days, and articles formerly made of wood are now being made of metal.

This book was written to give you, whatever your future vocation, some knowledge of metals and to suggest how you can develop skill in using them to make attractive and useful articles.

Highly specialized trades and industries have been developed to make things of metal, and these offer many worth-while careers. Although craftsmen and manufacturers usually engage in only one trade or manufacturing specialty, this book brings together information common to many kinds of metal working. No attempt is made to emphasize any one trade or manufacturing industry at the expense of others. Thus if your experience in working with metals should lead you into employment in any of the metals industries, you will find that this course will serve you well as a preparation for the career of your choice.

In addition, you can learn how to make working with metals an enjoyable and profitable hobby.

It is assumed that you will have the use of a school shop equipped with a few machines and tools. There is, of course, considerable satisfaction in having just the right tool or machine for every operation. However, if you do not have the one suggested in this book there is usually some other way to do the job. In other words, where there's a will there's usually a way.

It is important for you to work *safely* and *effectively*. The ability to plan a job in advance and then do the operations without injury to yourself or another worker and without wasting materials is perhaps the most important thing to learn through your experiences in general metal working. Therefore, in addition to learning facts and acquiring skills, you must strive to become careful and efficient.

We want you to have a most valuable and interesting experience in your explorations into making things out of metal. It is our hope that this book will be a real help to you.

THE AUTHORS

C H A P T E R

Metals—Their Properties and Uses

This chapter covers the following subjects:

Ferrous Metals, 1 • Nonferrous Metals, 3 • Alloys, 4 • Know Your Metals, 4

1

Metal in its original state is an ore that looks like clay or rock when taken from the mine.

Metals are divided into two main classes: *ferrous* and *nonferrous*. The word *ferrous* comes from the Latin word "ferrum," meaning iron. Ferrous metals are those made from iron, and nonferrous metals are those not made from iron.

Each kind of metal has qualities that make it desirable for certain articles. When selecting the proper material for a project, one should consider which qualities are most desirable. Ornamental ironwork requires a material that can be bent, twisted, extended, or stretched out; therefore, the workman must use stock that is malleable (see Fig. 1-1) as well as ductile (see Fig. 1-2). If one is to build a machine tool, the frame and the parts must be hard enough to resist any tendency to bend.

All ferrous metals, and steel in particular, are subject to attack by rust. Wrought iron and cast iron are less affected by such action. Since the nonferrous metals do not contain iron, they do not create a rust problem. Some chemicals are very destructive to many metals. This destruction by the elements or by chemicals is called corrosion.

Metals are said to possess fusibility when they can be melted easily with a torch or soldering copper.

Ferrous Metals

Iron is taken from the mine in the form of ore that looks like a reddish clay. The iron is removed from the ore by smelting in a blast furnace (see Fig. 1-3). The molten metal is drawn from the bottom of the furnace and

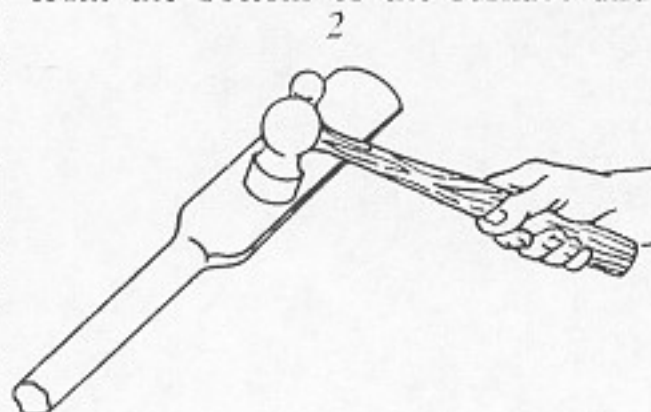


Fig. 1-1. A piece of metal can be shaped by hammering if the material is malleable.

poured into brick-like molds. Iron in this form is called pig iron and contains a large amount of carbon and other impurities.

Pig iron must be purified further and treated in furnaces to make cast iron, wrought iron, and steel. The excess carbon, sulphur, and other impurities are removed in various ways. If you wish to find how this is done, use an encyclopedia or a good book on metallurgy.

Cast iron is brittle (see Fig. 1-4) and usually grayish in color. It is made by melting and combining pig iron and scrap iron, and by pouring the molten

mixture into sand molds of various shapes. It can be machined; that is, it can be turned on a lathe or cut with a hacksaw, shaper, or milling machine. Because it possesses great strength and rigidity, it is used for the manufacture of machine parts. However, cast iron is very brittle and cannot be bent. Therefore, if it is struck a sharp blow or put under a severe strain it is liable to break or crack.

To summarize, cast iron is hard and brittle, and will break before it will bend. In other words, it is not malleable, and therefore cannot be stretched or formed by forging. It is *fusible* and can be joined by gas or electric arc welding.

Wrought iron is ductile and very tough. It can be bent either cold or hot. When heated in a forge almost to the melting point, it becomes soft and pasty. In this form, two pieces can be united or welded by hammering to form a single piece. At a red heat, it can be readily hammered or forged into any shape. For these reasons, ornamental ironworkers and blacksmiths use it to make many things. However, wrought iron cannot be used for cutting tools or wherever stiffness or spring is necessary.

Steel is the most highly refined form of iron. The science of metallurgy has developed a great variety of steels to meet the needs of industry. One type is

needed to make cutting tools, which

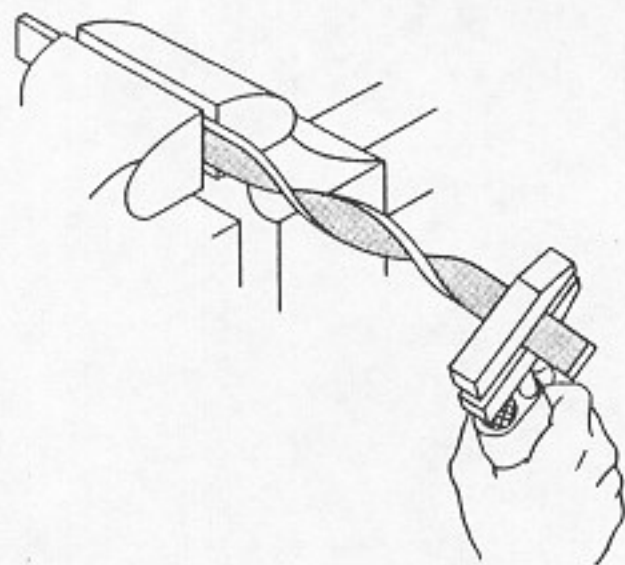


Fig. 1-2. A ductile metal can be shaped by twisting, bending, or stretching without breaking or cracking and it will not spring back into its original shape.

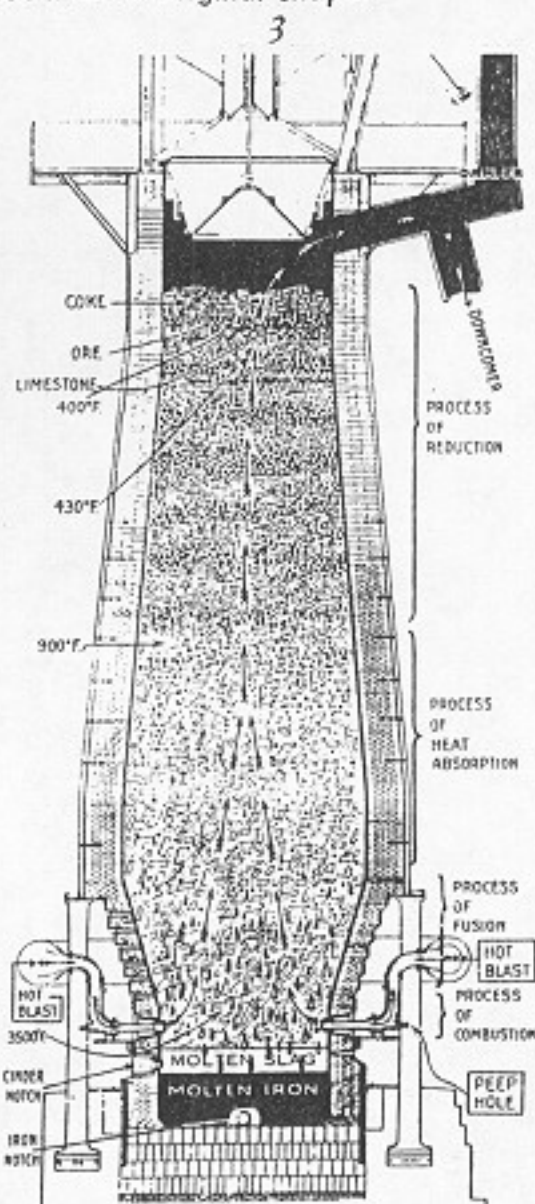


Fig. 1-3. The blast furnace is many feet high and holds many tons of coke, limestone, and iron ore. The molten iron is drawn from the furnace through the iron notch. (Courtesy American Steel & Wire Co.)

require a very high grade metal. Other types are used in building construction and in automobile manufacturing. Steel

can be machined, molded, or forged. By heat treating, it can be given almost any desired property of hardness (see Fig. 1-5), brittleness, malleability, ductility, or fusibility, and its corrosiveness can be controlled.

Nonferrous Metals

Nonferrous metals are metals that are not made of iron. Some of the more common of these are aluminum, copper, zinc, nickel, lead, and tin. Gold, silver, and platinum are referred to as precious metals, because of their scarcity. Nonferrous metals have been used by man for thousands of years. They are especially desirable for many purposes, because of their noncorrosiveness and the ease with which they can be formed into various shapes. They melt at a much lower temperature than iron. By heat treating, they can be kept soft while being formed.

Aluminum has been known for several years, but until recently separating it from bauxite was too expensive (see Fig. 1-6). Wherever electricity is available, aluminum can be separated from the bauxite cheaply enough for use, so that aluminum has become one of the more widely used metals in manufacturing. It is light in weight, strong, and not subject to rust.

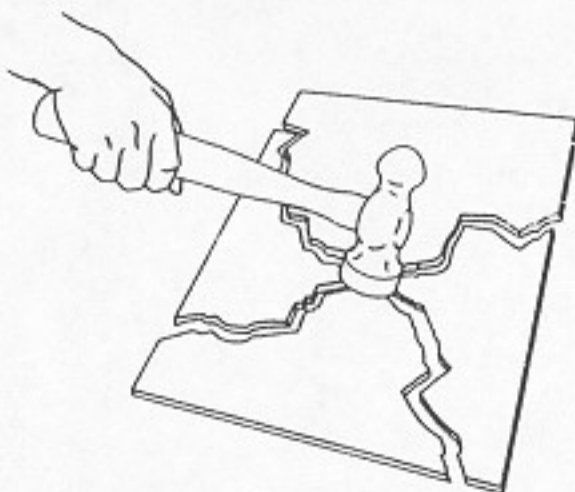


Fig. 1-4. Cast iron and hardened steel are types of metal that are brittle. They will shatter if struck a severe blow.

It can be produced in varying degrees of hardness and can be welded, molded, or drawn into wire.

Alloys

The science of metallurgy has made possible the combining of metals to produce *alloys*, which have qualities that no one metal alone has. In fact, relatively few base metals are used today in manufacturing. You are familiar with many alloys, such as *solder*, which is a mixture of tin and lead; *brass*, which is a mixture of copper and zinc; and *stainless steel*, which contains nickel.

Know Your Metals

The metals you will use for general metal work will be in the form of *sheets*, *round rods*, and *square, hexagonal, or octagonal bars* (see Table 1, p. 10).

The metals for melting may be in brick-like ingots. You may have castings that have been molded into shapes for machining. The various forms of metal come in standard sizes, but the price is quoted by the pound. They are

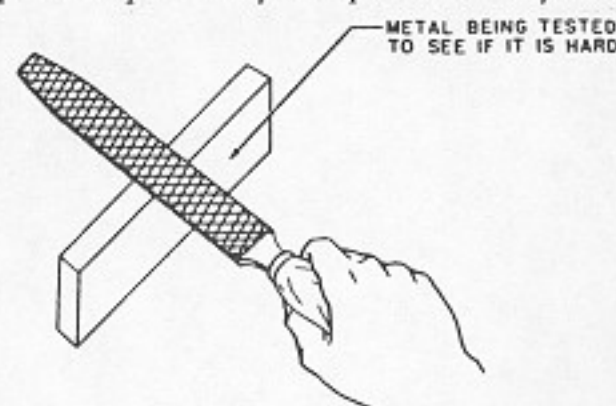


Fig. 1-5. Metal is hard if the file slides over the surface being tested without removing any material.

given identifying numbers, which indicate their degrees of hardness and other qualities. The worker must determine which qualities are required to make an article and then select the desired metal from a catalog by its number.

Your success in metal working will depend upon your choice of materials. If you are alert, you will learn to identify metals by their appearance, by their "feel," and by simple tests like bending, spark testing, or filing. You will find yourself struggling with the problem of using tools and machines, but do not neglect to become a keen observer of the metals with which you are working.



Fig. 1-6. Raw material (bauxite) for aluminum being removed from the earth. (Courtesy Reynolds Metals Co.)

CHAPTER 2

Planning

This chapter covers the following subjects:

General Precautions in the Metal Working Shop, 5 • Designing Attractive Projects, 6 • Making and Reading Working Drawings, 7 • Planning Your Project, 9

5

"Safety first" is a good slogan at any time, and especially so in a metal working shop. If you have seen the results of an industrial accident, you know that safety has a very real meaning, that there is a need for carefulness in following "safety first" practices in all shop work.

Did it ever occur to you that finishing the task at hand without injury to yourself or to your fellow workers is a most important responsibility? Yes, safety is the watchword of every successful person in industry.

For many years, industry has emphasized the safeguarding of machinery and the providing of good working conditions. Now the emphasis has been broadened to include the worker himself. The accident records of many companies show that most personal injuries occur because of someone's carelessness. Mishandling tools, machines, and materials, neglecting to

keep them in good condition, and leaving them about in dangerous places are forms of carelessness that cause trouble sooner or later. It is only by constantly keeping in mind the thought of safety as you plan your work that you can make yourself a good worker in the shop. Remember, an unsafe worker is an unwanted worker.

General Precautions in the Metal Working Shop

Accident hazards exist in the metal working shop. Your problem is to recognize those hazards. Set out to make yourself familiar with the safe use of your shop equipment and to acquaint yourself with the practices of the safe worker.

Power-driven machines are a great help to the worker and take the drudgery out of many metal working operations. However, the operator of the machine must be continuously alert to

avoid accidents. Any machine can be operated safely if the operator is the master of it, but not if the machine is the master of the operator. If only a few simple precautions are included in your plan of work and observed, the danger of machine operation is reduced to a minimum. Each machine has its particular points of danger with which the operator must become acquainted. Since many of the principles under which machines operate are fundamentally the same, operators can form certain habits of safety that apply to all machines. In planning we must recognize that the safe way to perform an operation is always the right way.

The thought of danger is especially associated with machines in motion. However, a surprising number of the injuries received in general metal shops result from the incorrect use of hand tools.

6

Designing Attractive Projects

There is an old saying, "A job is half done when it is well planned." Your purpose is, after all, to make something worth while, something that is attractive. This requires careful planning. There are four distinct phases in planning a project. First, it must be *designed*. The beauty and attractiveness of any project is largely dependent upon how well it is designed. Second, a *working drawing* is necessary. The working drawing shows sizes and shape as well as the materials required. Third, the careful craftsman will write down a *step-by-step procedure* for each operation or process that is to be performed. Fourth, safety precautions *must* always be noted for each operation. Planning should be done completely before starting to work. To begin work before the job has been planned from start to finish is only inviting trouble. Tools will be misused, materials will be spoiled, and a poorly-designed project will be the result.

There is a great deal of satisfaction in designing one's own project. Designing requires experience. The shapes and sizes of many useful articles have become pretty well established. One should study carefully available pictures of a desired project and if possible examine a finished unit. Often, by just a small change, a "new look" can be given some common article.

In designing projects to be made in the general metal shop, lines that are straight ———, wavy ~~~~~, or curved  should be combined into shapes that go together well to make up a good creation. It is important to remember, however, that the shapes must be suited to the material of which the article is to be made. Above all, the finished project must be suited to the use for which it is intended.

Helpful Suggestions Before Designing a Project. As you design or modify your project, it may be helpful

if you give some thought to the following suggestions:

1. What will it be used for—as a room decoration, as a tool, to hold something, or to set things on?
2. Where is it to be used—in the garage, in your room, in the basement or as a gift?
3. What size or shape should it be to fit best into the surroundings where it is to be used?
4. From what materials will it be made (see Table 1) and is the material available?
5. How will you construct it—by machine, from pieces held together, by soldering or rivets, or entirely from one piece?

Having raised and answered these and other questions, you must now put your ideas on paper in the form of a drawing.

Making and Reading Working Drawings

In any event, try to get a pretty clear idea of the design you want before you try to make the working drawing. Making the working drawing is an essential part of any job. Drawings may be done with instruments; however, the *shop sketch* made free-hand is all the workman needs to guide him in making many projects. In any case, the freehand shop sketch should precede the making of a drawing with instruments. The working drawing is made right from the design. The making of a working drawing and the designing of a project are inseparable.

One has a clearer understanding of the shape, size, materials, processes, and operations when one makes one's own working drawing. But craftsmen must frequently make an object that has been designed and drawn by someone else. In fact, the drawings used by a machinist in a plant are usually made in a drafting room by draftsmen. When you use a drawing made by

someone else, it is necessary for you to be able to read it. Reading a working drawing is called *blueprint reading* because working drawings are usually printed on a paper that is blue.

The making of sketches and the reading of drawings will be important parts of your work in the general metal shop. You may believe that the best way to find out how to make something would be to look at a good photograph of it. However, this would give you only a general idea of its construction. For more specific information, you would have to look at the top and all sides, as well as the inside if

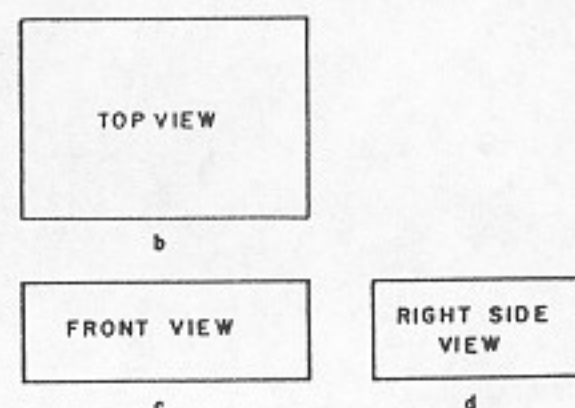
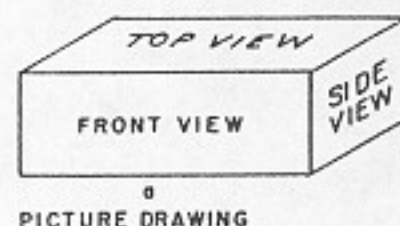


Fig. 2-1. Drawings are sometimes made to show 2 or more views of the object.

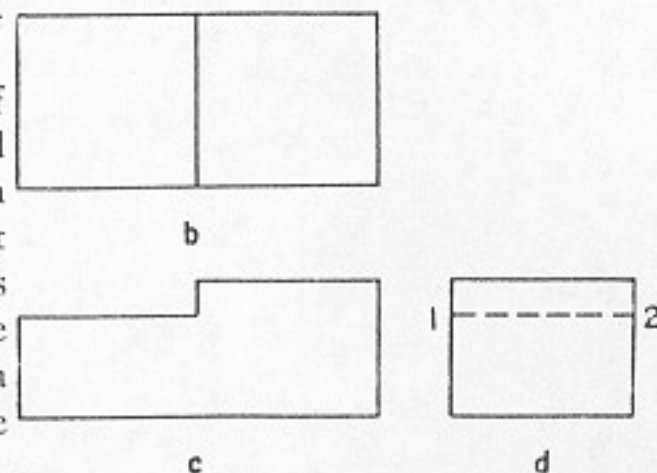
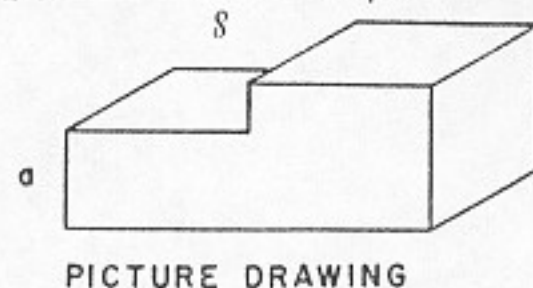


Fig. 2-2. Drawings having two or more views

would be difficult to understand if the views were not properly placed and in line with each other.

it is hollow. Therefore, a sketch or working drawing is made that represents at least two of three views of the object. The views most generally used are the top, front, and side, as shown in Fig. 2-1a.

To visualize this type of drawing better, think of a small block of metal about the size of a match box. If we place this block on the top of a table and look directly down at it, it appears as shown in Fig. 2-1b. You are looking directly down on it and see the top view. Change your position and place yourself directly in front of it. Then, kneel down so your eyes are level with the block. From this position you see what is called the front view, as shown in Fig. 2-1c. Now move around to the side of the block and again kneel down at eye level with it. You get a picture of it as shown in Fig. 2-1d, which is the right-side view.

The location of these three views—top, front, and right side—on a drawing sheet is understood by mechanics and engineers everywhere. Therefore these views are always placed on the drawing sheet in the same relation to each other.

Now, study Fig. 2-2d carefully and you will find that in the right side view of the drawing there is a broken line (---) 1-2. This kind of line is called a hidden line and is used in drawings to show edges or other outlines

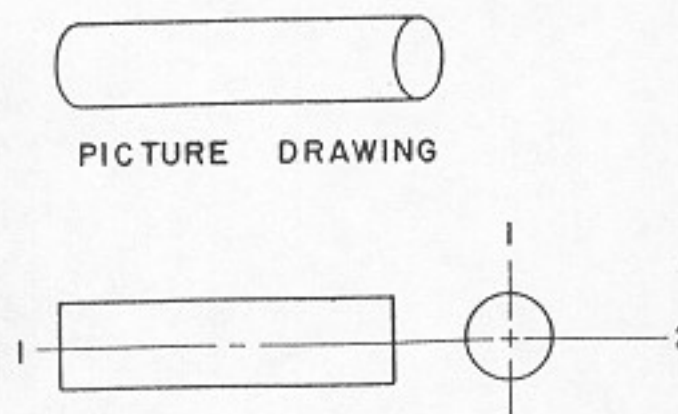


Fig. 2-3. The centers and locations are shown with a --- center line.

that are hidden from view. The broken or hidden line is also used to show the location of holes that cannot be seen in certain views of a drawing.

In Fig. 2-3 you will see another type of line (— — — — —) and is known as a *center line*. It is used to show the location of the centers of round parts or holes.

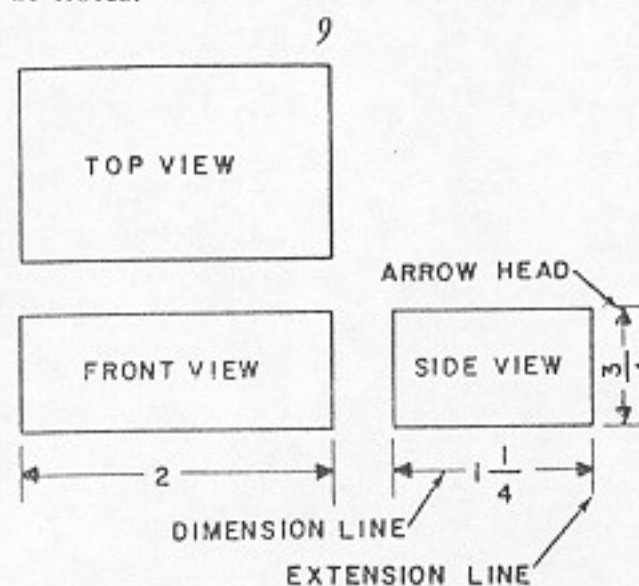


Fig. 2-4. Dimension lines indicate on a drawing the exact measurements on the object.

Up to this time we have talked about the size of the block in general terms. You should now become acquainted with the method of indicating exact sizes and measurements on a drawing.

The block used (see Fig. 2-4) is $\frac{3}{4}$ " thick and $1\frac{1}{4}$ " wide and 2" long. These dimensions have been placed on the drawing through the use of extension lines, dimension lines, and arrow-heads.

Planning Your Project

In industry, the producing of a product starts after it has been designed and working drawings have been made. The first step in production is to prepare carefully a plan of work. The same is true in the general metal shop. From the working drawings or sketches that have been prepared from the approved design, a plan of work is made that will be followed in making the project.

Suggested Projects. The selection

of a project often presents quite a problem, for often when you are asked what you would like to make in the general metal shop, you are at a loss for an idea. Perhaps one of the following suggestions may be of some help:

Book Ends	Cast Paper Weights
Candy Dish	Cast Ash Trays
Fruit Bowl	Cast Serving Dishes
Ash Tray	Cigarette Box
Spice Shelf	Match Box
Towel Rack	Name Plates
Flower Box	Letter Holders
Flower Pot	Tool Box
Flower Pot Hanger	Fishing Tackle Box
Weather Vane	Notebook Corners
Ornamental Wrought Iron Objects	Lamps
Hammers	Coasters
Tools of Different Kinds	Candlesticks
Cast Book Ends	Door Knockers
	Door Stops
	Lawn Ornaments
	Magazine Racks

There are many others that I am sure you can think of. Quite often suggestions from others can help a lot in figuring out what to make.

Deciding If the Project Is Suitable Or Not. After you have selected your project, the following questions will help you decide if it is suitable:

- Are you interested in making this project?
- Will you be able to make it?
- Have you made certain that the tools and materials are at your disposal?
- Will the project take more time to build than you have to spend making it?
- Will the materials cost more than you wish to spend?
- Have you seen an article similar to the project you wish to make?
- What do others think of the project you plan to make?
- Will you learn something new in making this project?

Sketching and Planning Your Project. To make the drawing, work on a page of your notebook or on a piece of paper as shown in Fig. 2-5. It will be noted that light lines one half-inch apart have been made on the paper

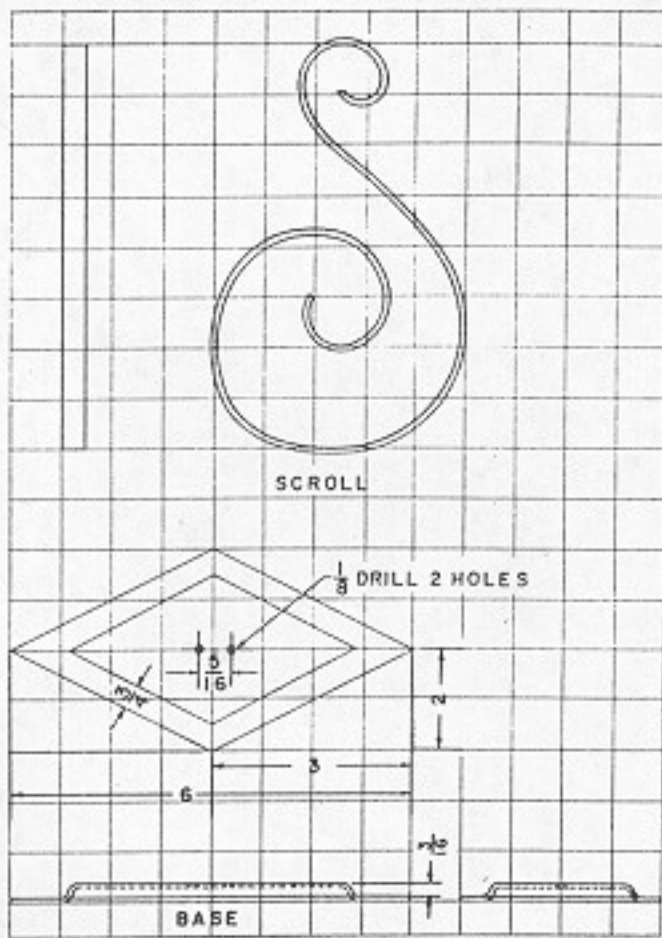


Fig. 2-5. Student's drawing of a project as he plans to make it.

used in the illustration. They are helpful in making your drawing.

If the project you have selected is composed of two or more pieces, you will need to make separate working drawings for each piece.

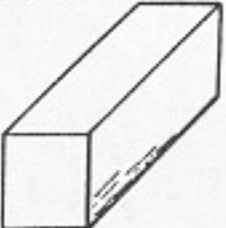
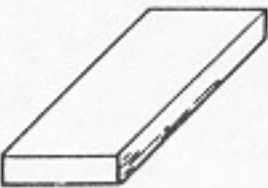
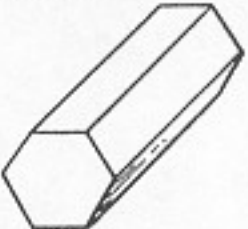
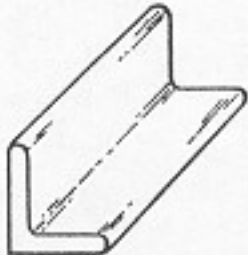
It will now be necessary to decide what size and kind of material to use in making the project. When you have made a list of the material and the size of each piece, you have what is known as a *bill of material*. It may be helpful for you to study Table 1, which shows and lists the different kinds of materials used in metal working. The table may also help to improve the design of your project, as well as to give you the correctly spelled name and an idea of the different uses of each kind of material.

The bill of material and your plan of work can be attached to your drawing.

See the suggested planning sheet and the plan of work for a table lamp made of band iron.

After completing your planning sheet, you should carefully analyze your drawing to decide what should be done first. Once you have decided, explain the first step clearly, using as few words as possible. Then list the

TABLE 1
MATERIALS USED IN METAL WORKING
(1) Bar and Angle Metal

Material	Suggested Sizes for School Use	How Purchased	Use
Band Iron or Hot Rolled Strip	$\frac{1}{8}$ " x $\frac{1}{2}$ " $\frac{1}{8}$ " x $\frac{3}{8}$ " $\frac{1}{8}$ " x $\frac{1}{4}$ " $\frac{1}{8}$ " x 1"	16-ft. lengths by the pound	Ornamental or wrought iron projects.
 Square, Cold Finished	$\frac{1}{8}$ " x $\frac{1}{8}$ " $\frac{1}{2}$ " x $\frac{1}{2}$ " $\frac{3}{8}$ " x $\frac{3}{8}$ " $\frac{1}{4}$ " x $\frac{1}{4}$ " A1S1 C1018 or SAE 1020 steel	10- to 12-ft. lengths by the pound	Metal projects that are not to be bent or formed. Good machining qualities.
 Round Shafting, Cold Finished	$\frac{3}{16}$ " $\frac{1}{4}$ " $\frac{3}{8}$ " $\frac{1}{2}$ " $\frac{5}{8}$ " $\frac{3}{4}$ " 1" A1S1 C1018 or SAE 1020 steel	10- to 12-ft. lengths by the pound	Metal projects that are not to be bent or formed. Good machining qualities.
 Flat, Cold Finished	$\frac{1}{4}$ " x $\frac{1}{4}$ " $\frac{1}{4}$ " x 1" $\frac{1}{2}$ " x 1" $\frac{1}{8}$ " x $\frac{1}{2}$ " A1S1 C1018 or SAE 1020 steel	10- to 12-ft. lengths by the pound	Metal projects that are not to be bent or formed. Good machining qualities.
 Hexagon, Cold Finished	$\frac{1}{8}$ " $\frac{1}{2}$ " $\frac{3}{4}$ "	10- to 12-ft. lengths by the pound	Metal projects that are not to be bent or formed. Good machining qualities. For projects and shop construction.
 Angles, Hot Rolled	1" x 1" x $\frac{1}{8}$ " $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $\frac{3}{16}$ " 2" x 2" x $\frac{1}{4}$ "	20- to 30-ft. lengths	
 Copper (soft)			
(2) Sheet Metal			
	Sheets or Rolls 18, 20, 22 gage	By weight	Art metal projects; can be spun, raised, or used flat; high or satin finish.

tools that you will use in the space provided on your plan of work. The tools and equipment that you will use and how to use them are described elsewhere in this book.

After your plan of work has been made, it is a good idea to check each step carefully to make certain that you have not overlooked something. Your plan of work can be checked by answering the following questions as they apply to the plan you have just completed.

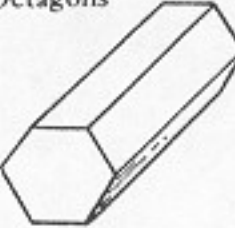
1. Have you studied the working drawing until you are thoroughly familiar with it?
2. Are the planning steps in sequence—the first one first and the last one last?
3. Is all the information concerning the materials included, such as sizes, amounts, and kind?
4. Will you lay out your job or is a template available?
5. How is the piece to be shaped—by sawing, filing, cutting, or spinning?
6. Are there holes to locate, to punch, or to drill?
7. How are the pieces to be assembled—by soldering or by riveting?
8. How is the desired finish to be obtained—by sanding, buffing, or polishing?
9. Is the job to be painted, lacquered, or waxed?
10. Are all the tools listed?

After checking your plan of work, it is best to review it with your teacher.

Questions

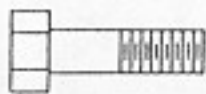
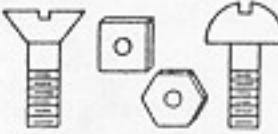
1. Name four tools or instruments that are used in making drawings.
2. How is a tracing of a drawing made?
3. What is the purpose of a tracing?
4. How are blueprints made?
5. How does the metal to be used affect the design of your project?
6. Why is it important to consider how the project is to be used before you design it?

12	Material	Suggested Sizes for School Use	How Purchased	Use
	Brass (soft)	Sheets or Rolls 18, 20, 22 gage	By weight	Art metal projects; can be spun, raised, or used flat; finish is of a high golden color.
	Aluminum 2S0	Sheets or Rolls 16, 18, 20 gage	By weight	Art metal projects; can be spun, raised, or used flat; finish is of a silvery satin.
	Pewter	Sheets 12" x 18" 18" x 24" 24" x 36" 16 to 18 gage	By weight	Art metal projects; can be spun, raised, or used flat; finish is of a silver color.
	Galvanized Iron	30" x 96" 22, 26, 28 gage	By weight	Almost any sheet metal project (28 gage for small projects).
	Black Iron	30" x 96" 20, 22, 28 gage	By weight	Projects that will be painted (28 gage for small projects).
	Tin Plate	20" x 28" 30 gage	By weight	Food containers.

(3) Tool Steel				
Round, Water Hardening		$\frac{1}{8}$ " $\frac{1}{2}$ "	10- to 12-ft. lengths by the pound	Punches.
Octagons		$\frac{1}{8}$ " $\frac{1}{2}$ " $\frac{3}{4}$ "	12- to 14-ft. lengths by the pound	Punches and cold chisels.
Drill Rod, Polished		$\frac{1}{8}$ " $\frac{3}{16}$ " $\frac{1}{4}$ "	3-ft. lengths	Small tools and dowel pins.

13

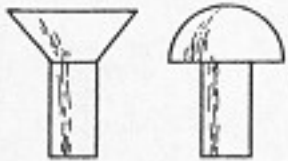
(4) Used in the Assembly of a Project

Hexagon Head Cap Screw		$\frac{1}{4}$ " (dia.) by $\frac{1}{4}$ " NC or NF* $\frac{5}{16}$ " (dia.) by $\frac{3}{8}$ " NC or NF $\frac{3}{8}$ " (dia.) by 1" NC or NF	By the hundred	To fasten parts together.
Machine Screws		6-32- $\frac{1}{4}$ " to 1 $\frac{1}{2}$ "† 8-32- $\frac{1}{4}$ " to 1 $\frac{1}{2}$ " 10-24-1" to 2"	By the gross	To fasten metal parts together.

* NC and NF refer to National Coarse and National Fine thread.

† These numbers refer to diameter of screw, threads per inch, and length of screw, respectively.

7. Why are the three views of a drawing lined up with one another?
8. For what reasons are hidden edge lines used in drawings?
9. Why is it best to plan your project before starting to make it?
10. In what ways does your sketch or a drawing help you in making your project?
11. What is the purpose of guards on machines and why should they always be left in place?
12. Why is safety as important to you as to the person next to you?
13. What is the basis for safe operation of a machine?
14. What is the basis for the safe use of hand tools?

Material	Suggested Sizes for School Use	How Purchased	Use
Flat Washers 	#6 #8 #10 $\frac{1}{4}$ " $\frac{3}{16}$ " $\frac{1}{2}$ "	1-pound boxes	Used around a bolt or screw to form a seat for the head or nut.
Tinner Rivets 	8 oz. 12 oz. 1 lb. 2 lb. Both black iron and tinned $\frac{1}{8}$ " by $\frac{1}{16}$ " $\frac{3}{16}$ " by 1"	By the box	To fasten or rivet metal parts together.
Rivets 	$\frac{1}{8}$ " by $\frac{1}{4}$ " $\frac{1}{8}$ " by 1" Aluminum, brass, copper, and iron	By the pound	To fasten aluminum, copper, brass, or other metal parts together.

(5) Miscellaneous Items

Wire 	10 or 8 gage galvanized	By the pound	For sheet metal jobs.
	14 or 12 gage copper and brass	By the pound	For art metal jobs.
	18 or 19 gage black annealed	By the pound	For tying projects together when soldering.
Tubing 	$\frac{1}{8}$ " $\frac{3}{16}$ " $\frac{1}{4}$ " $\frac{5}{16}$ " Annealed, flexible copper	By the pound	For art metal projects.
Pipe 	$\frac{1}{8}$ " Black iron and brass	12-ft. lengths By the pound	For lamps.

14

THE PLANNING SHEET

Name of Job _____

A. Materials Needed

Date _____

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.

B. Steps in Doing the Job

Tools and Equipment _____

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

C. Assemble

Foreman's Mark _____

Teacher's Mark _____

(Make Drawing on Back)

SAMPLE PLAN OF WORK

Table Lamp

A. Materials Needed

1. Band iron $\frac{1}{8}$ " x $\frac{1}{2}$ " x 17"
2. Black iron (18 gage) $4\frac{1}{8}$ " x 6"
3. 2 rivets (round head) $\frac{1}{8}$ " x $\frac{1}{4}$ "
4. Emery cloth, fine
5. $\frac{1}{8}$ " pipe, threaded, $\frac{1}{2}$ " long
6. Lamp socket, wire, attachment plug

B. Steps in Doing the Job

Tools and Equipment

Scroll

1. Get out metal
2. Measure length
3. Cut to length
4. File ends
5. Flare ends
6. Form scroll
7. Drill $\frac{1}{8}$ " holes for rivets
8. Drill $1\frac{1}{32}$ " hole for $\frac{1}{8}$ " pipe
9. With $\frac{1}{8}$ " pipe tap cut threads in $1\frac{1}{32}$ " hole

Rule and scriber
Hacksaw
File
Hammer and anvil
Bending fork and vise
 $\frac{1}{8}$ " drill and drill press

Base

1. Get out metal
2. Measure length and width
3. Cut to length and width
4. Lay out diamond
5. Cut out diamond
6. File all edges
7. Lay out diamond shape for raised part of scroll and locations for drilling rivet holes
8. Raise base
9. Drill holes for rivets

Rule, square, scriber
Hacksaw or cold chisel
Rule and scriber
Hacksaw or cold chisel
File and vise

Rule and scriber
Vise, hammer, piece of metal with rounded end, center punch
 $\frac{1}{8}$ " drill and drill press

C. Assemble

1. Rivet scroll to base
2. Attach socket to scroll and wire socket

Measuring and Layout Tools

This chapter covers the following subjects:

Coloring Metal Surfaces Before Laying Out, 17 • Scriber, 18 • Steel Rule, 18 • Squares, 19 • Prick Punch, 21 • Spring Dividers, 22 • Calipers, 23 • Outside Micrometer, 25 • Gages for Wire and Sheet Metal, 27 • Pattern or Template, 27

Before cutting, bending, or forming metal, the dimensions indicated on the blueprint or working drawing must be located and marked on the metal. This is done by first measuring from a true edge or surface to determine the location of important points. Layout lines are then made by scribing fine lines that pass through the points. These important points and lines are then permanently marked by making very small indentations with a prick punch, to guide the mechanic in cutting edges, in drilling holes, and in bending.

This whole process of transferring measurements from a drawing to metal is called *layout*.

Coloring Metal Surfaces Before Laying Out

The surface of a piece of metal may be colored to permit one to see readily the lines that are to be made on it. For this reason, the first step in laying out a job usually is to color the surface on which the layout lines are to be made. Smooth surfaces may be colored with purple layout dye or a copper sulphate solution; rough surfaces may be colored with a whitewash or white chalk dust.

Purple Layout Dye. Layout dye is a purple liquid. It is used to color the surface of iron and steel before layout work is begun. Whereas fine lines scribed on bare metal are not easily

seen, fine lines made through the dye and into the metal will show bright against the purple.

A substitute for layout dye is a copper sulphate solution. To make it, add copper sulphate crystals (Blue Vitriol) to 4 ounces of water until no further crystals will dissolve. Then add 10 drops of sulphuric acid. CAUTION:

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ALWAYS ADD ACID TO WATER. When applied to a metal surface, this solution produces a very thin coating of copper.



Fig. 3-1. Scriber. (Courtesy L. S. Starrett Co.)

Scriber

The scriber (see Fig. 3-1) takes the place of a pencil for marking layouts on metal. Because the point of the scriber must be fine and sharp, it is made of hardened steel.

When it is necessary to scribe a line through two points, place the point of the scriber on one point, place ruler against scriber, and line up the ruler with the other point, thus making it possible to draw the line through both points.

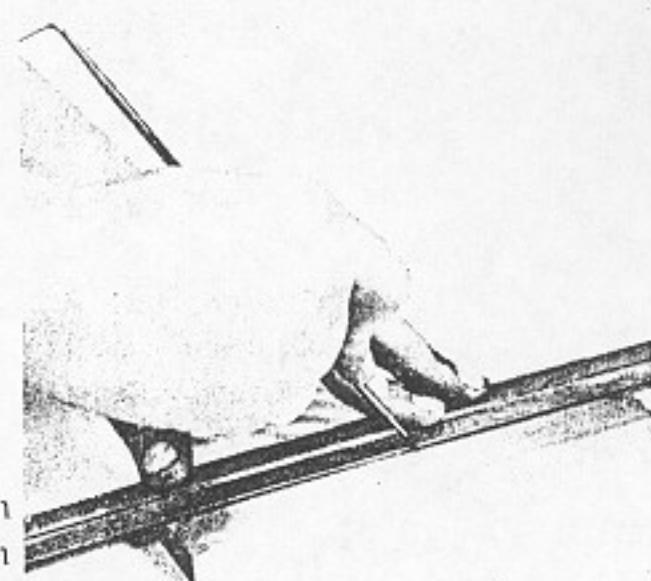


Fig. 3-2. Use the edge of a straight piece of metal or a steel rule to guide the scriber. When scribing the line, keep the point of the scriber on the metal and against the straight edge.



Fig. 3-3. Steel Rule. (Courtesy L. S. Starrett Co.)

Steel Rule

The steel rule (see Fig. 3-3) is the most common measuring instrument in use. It is a strip of hardened steel containing line graduations that show fractional parts of an inch. It is made in various widths, lengths, and degrees

of flexibility. Typical uses of the steel rule are to measure thickness, width, and length. It is also used as a straight-edge to check surfaces and edges for straightness and to guide the scriber when making a straight line between layout points.

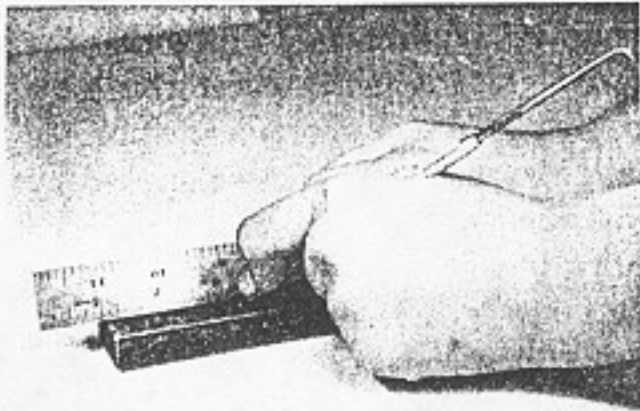


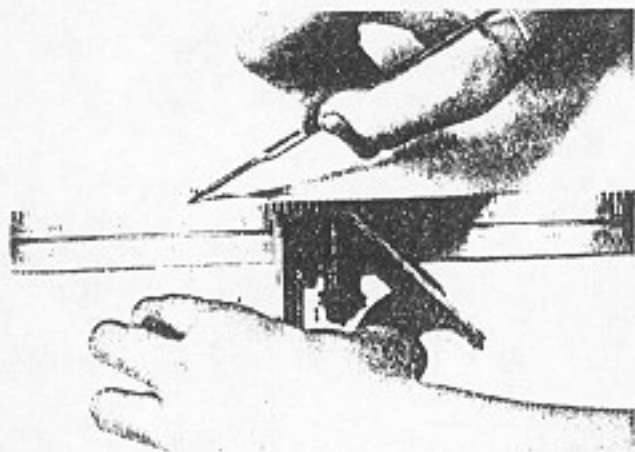
Fig. 3-4. Hold the rule on its edge so that the graduation marks rest directly on the surface being measured.

Measuring with a steel rule should always be done from a straight line, side or edge of a piece of metal. When making accurate measurements, it is considered better to hold the one-inch graduation mark, rather than the end of the rule, even with an edge or side of the metal (see Fig. 3-4). Mark the metal with a scriber opposite the desired measurement.

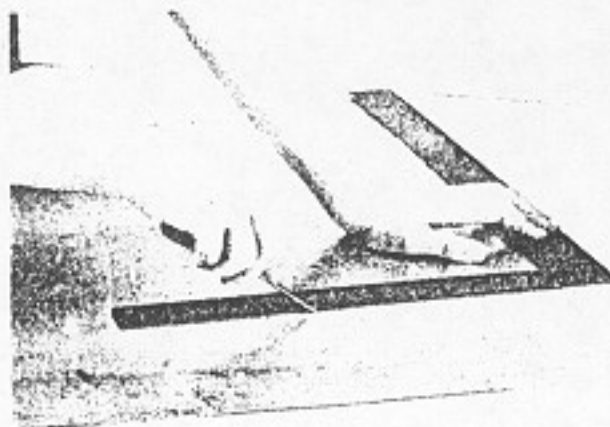
Squares

Squares (see Fig. 3-5) are sometimes used for making measurements, but they are used more often for laying out and checking angles. The solid steel square, the steel square, and the double square are all designed to check right

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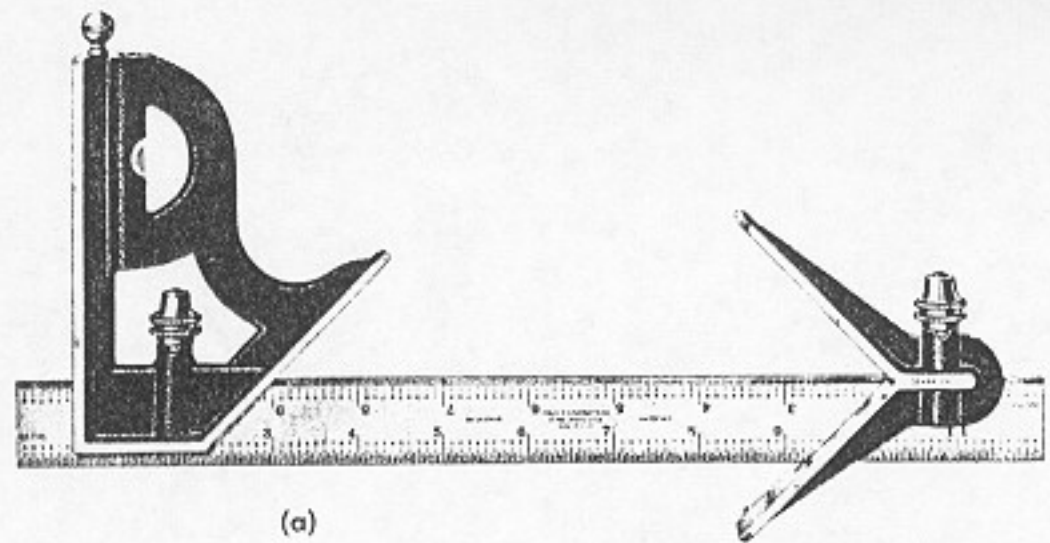
(a) Squaring a line across a bar of metal.



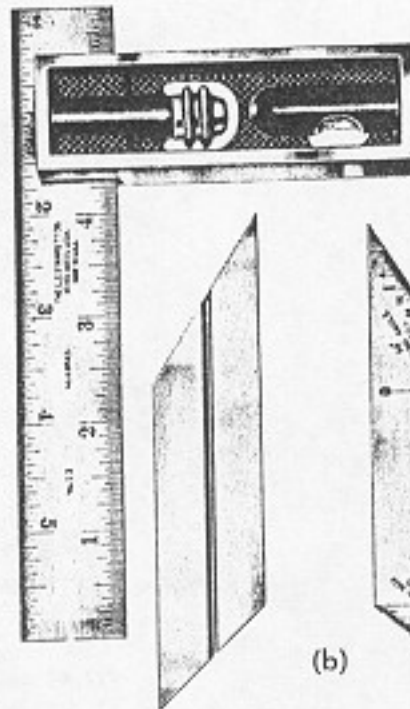
(b) Squaring a line on a piece of sheet metal.

Fig. 3-6. Always keep the sharp point of the scriber against the blade of the square when scribing a line.

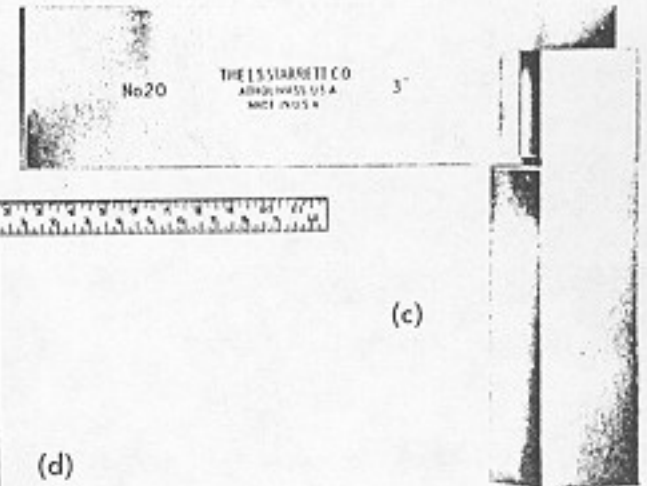
(90-degree) angles. Combination squares are used to measure, lay out, and check 45-degree angles as well as 90-degree angles. The head of this square may also be used as a level.



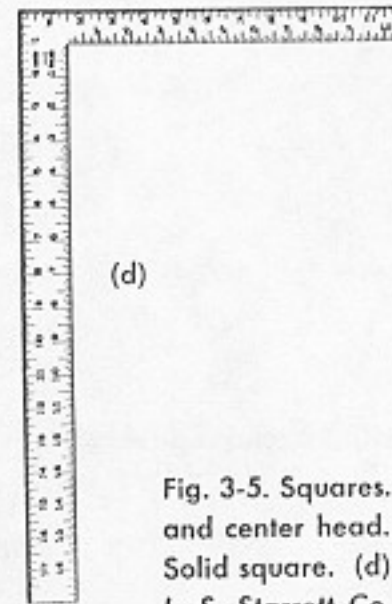
(a)



(b)



(c)



(d)

Fig. 3-5. Squares. (a) Combination square and center head. (b) Double square. (c) Solid square. (d) Steel square. (Courtesy L. S. Starrett Co. and Stanley Tools.)

Using a Square to Scribe a Line Across a Piece of Metal. To scribe a line across a piece of metal with a square (see Fig. 3-6), hold the head of the square against a true edge or side of the metal, with the blade of the square lying across the flat metal surface. The top edge of the blade must touch the layout point where the line is to be scribed. Along the edge of the blade, scribe the line across the metal.

Using a Square to Test the End or an Edge of Metal for Squareness. To test an end or an edge of a piece of metal for squareness, hold the blade of the square on a flat surface of the metal with the head of the square held against a straight edge or side of the metal. Move the blade of the square to the end of the metal. If the end of the metal is even with the edge of the blade, per-

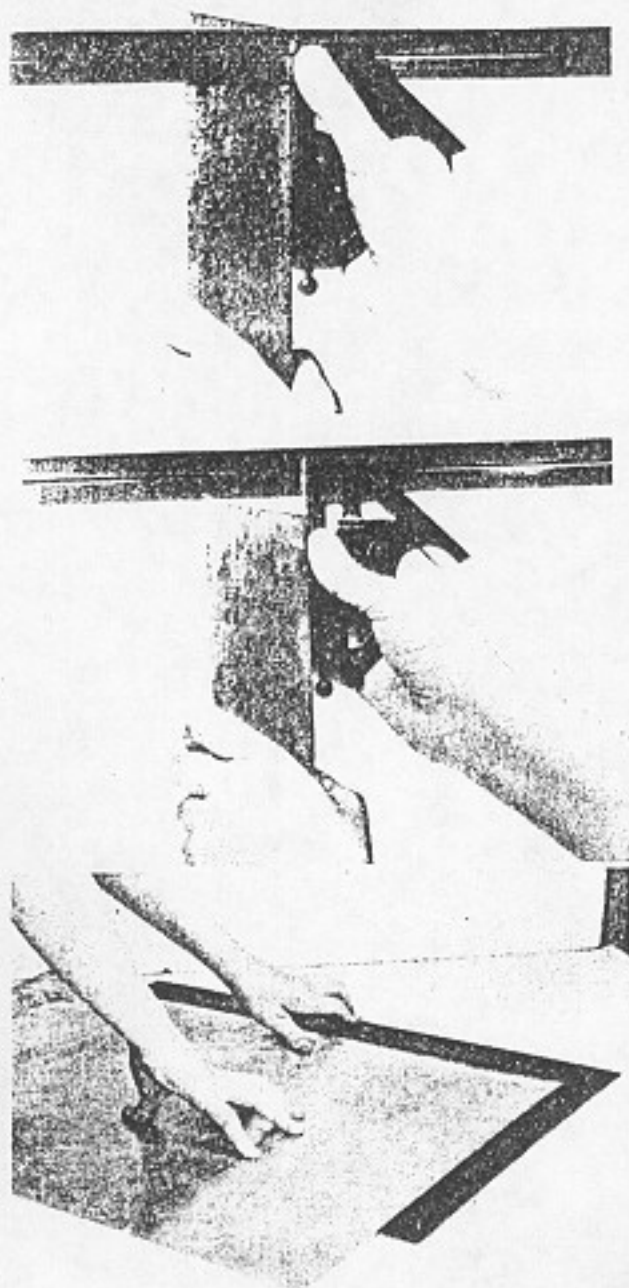


Fig. 3-7. The combination square, double square, or solid steel square is used when testing bar steel for squareness, and the steel square for metal that is hot or in sheet form.

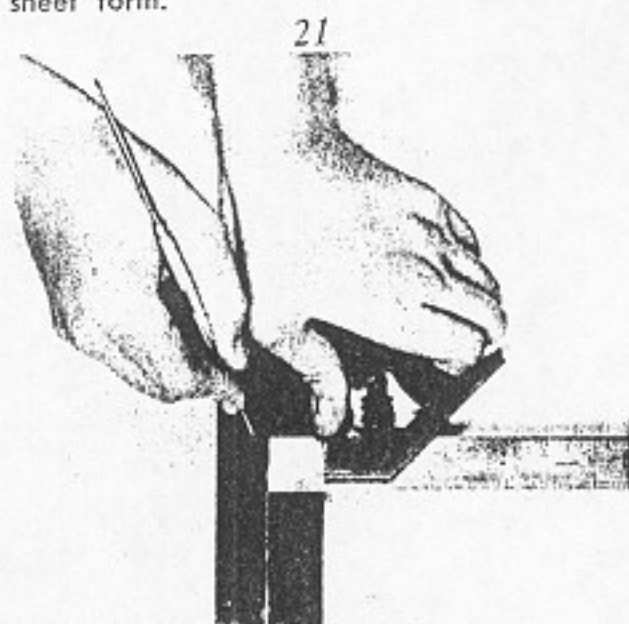


Fig. 3-8. The head of the square must be kept against the edge of the metal, or the line being scribed will not be parallel to the edge.

mitting no light to show through, the

end of the metal is square (see Fig. 3-7a). Another method is illustrated in Fig. 3-7b. The steel square (Fig. 3-7c) is used to test the squareness of sheet metal.

Using a Combination or Double Square to Scribe a Center Line or a Line Parallel to an Edge. The end of the blade of either a combination square or a double square (Fig. 3-5a and b) is often used as a guide for the scribe when a line is to be scribed parallel to an edge. To set either square to a given measurement, loosen the clamping screw on either the combination or the double square. Slide the blade through the head. Tighten the clamping screw when the graduation equal to the measurement desired is even with the edge of the head. Then hold the head of the square against the edge of the metal and the scribe against the end of the blade (see Fig. 3-8) while sliding the square along the edge. When this is done, a line is scribed that is parallel to one edge of the metal.

Prick Punch

The prick punch (see Fig. 3-9) is used to make small indentations on layout lines and to locate the centers of arcs and circles. It is a sharp, pointed tool that is struck very lightly with a

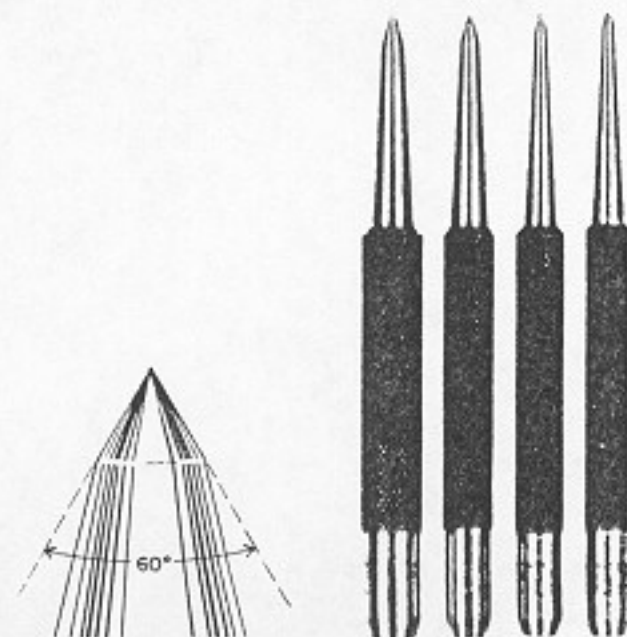


Fig. 3-9. Prick Punch. (Courtesy L. S. Starrett Co.)

small, lightweight hammer. The point is hardened and sharpened to a 30-degree angle.

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Using a Prick Punch to Punch Along Layout Lines. The fine layout lines that have been scribed on a colored metal surface are likely to get worn off while the metal is being worked on. Therefore, before work is started, these lines should be prick punched to make them easier to locate. The prick punch marks should be right on the layout line. They may be spaced from $\frac{1}{8}$ " to $\frac{1}{4}$ " apart and should be about $\frac{1}{64}$ " deep.

Using a Prick Punch to Mark Measurements on Metal for Forging, Twisting, and Bending. When metal is hot enough to forge, it is difficult to see the layout lines that have been made on it. Before heating the metal, therefore, measure and mark

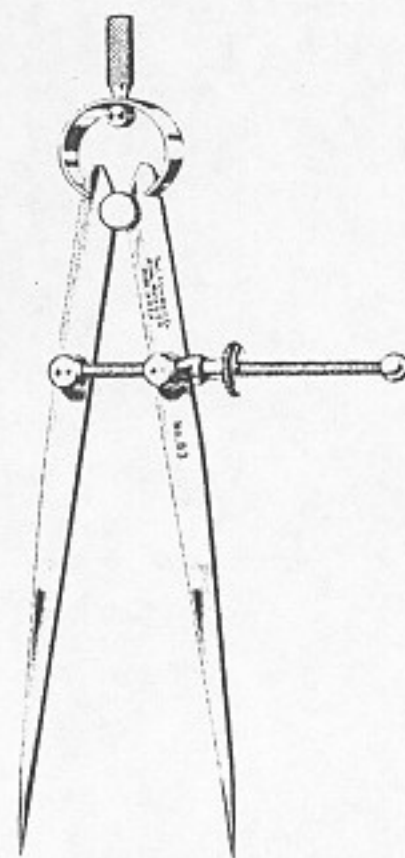


Fig. 3-10. Spring Dividers. (Courtesy L. S. Starrett Co.)

with prick punch indentations the location for forging, twisting, or bending. The punch marks will be seen easily when the metal is hot.

Spring Dividers

Spring dividers (see Fig. 3-10) look

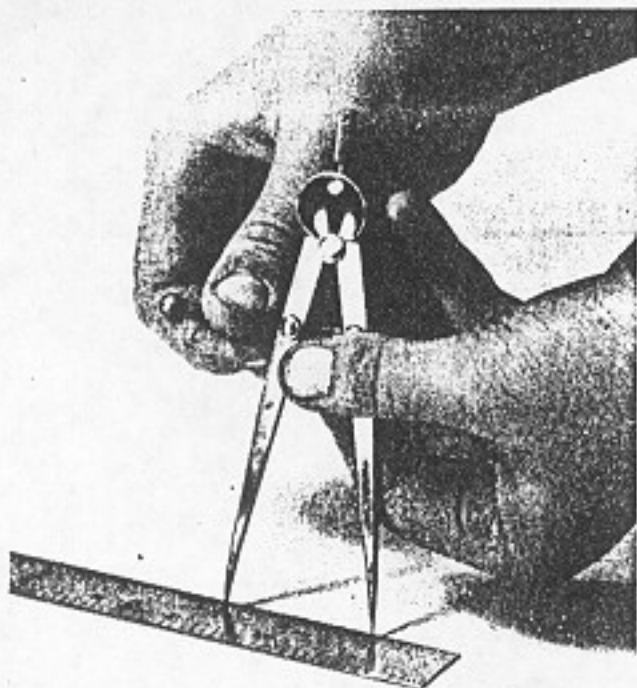


Fig. 3-11. The setting of dividers is made easier when the rule is laid flat on a bench.

like a compass, except that both legs have sharp hardened steel points. Spring dividers are used for spacing, for transferring measurements from one location or piece of metal to another, and for scribing circles and arcs on metal.

Setting a Pair of Spring Dividers. To set a pair of spring dividers, place the point of one leg in one of the inch graduations of a rule (See Fig. 3-11). Then open the dividers until the point of the other leg rests in the graduation at the desired distance.

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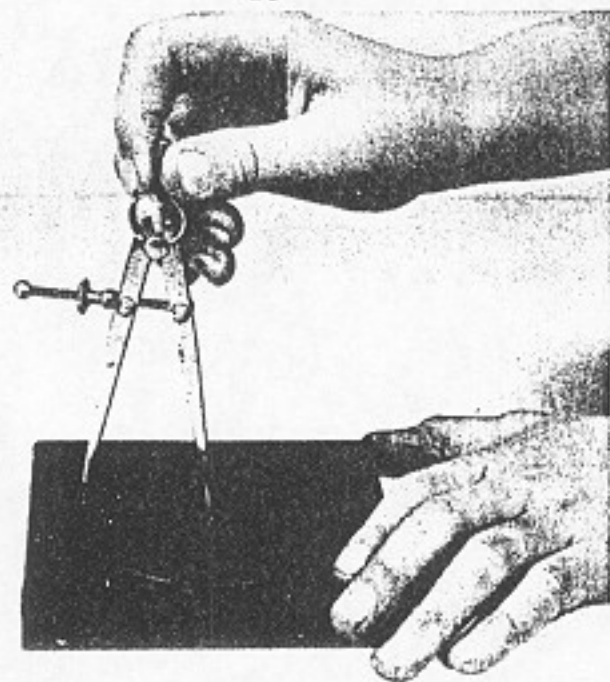


Fig. 3-12. When swinging the divider, keep the point of one leg pressed firmly in the prick punch mark which locates the center of the circle.

Using a Pair of Dividers to Scribe a Circle. To scribe a circle with a pair of dividers, first set the dividers to one-half the diameter of the circle. After laying out the location for the center of the circle, prick punch it and insert the point of one divider leg into the mark (see Fig. 3-12). Then swing or turn the dividers, and scribe a circle on the metal with the other point.

Calipers

Calipers (see Fig. 3-13) are used to gage the distances between outside or inside surfaces. Like a compass or dividers, they have two legs. Gaging is done by adjusting the calipers to fit exactly the object to be measured. The distance between the ends of the two legs is then measured with a steel rule. Outside calipers gage the distance between outside surfaces; inside calipers gage the distance between inside surfaces.

Using a Rule to Set Outside Calipers to a Given Measurement. To set outside calipers to a given measurement, hold the end of one leg on the end of a steel rule (see Fig. 3-14). Set by turning the adjusting nut until the end of the other leg is even with the measurement desired. There are two possible sources of incorrect measuring with calipers: incorrect setting and improper handling.

Using Outside Calipers to Determine Outside Measurements. To determine outside measurements, first open the outside calipers until the opening is larger than the metal to be measured. Hold the spring joint with the fingers of one hand (see Fig. 3-15) and carefully slide the calipers over the work while slowly tightening the adjusting nut until the points of the legs slide over the metal with a very light touch against it. After the calipers are adjusted correctly, the measurement may be secured by placing the calipers on a rule as shown in Fig. 3-14.

Using a Rule to Set Inside Calipers to a Given Measurement. To

set inside calipers to a given measurement, one end of a rule should be held squarely against a block of metal or a solid surface (see Fig. 3-16). Then hold one leg of the inside calipers against the metal block and on the rule. Turn the adjusting nut until the other leg is even with the desired measurement.

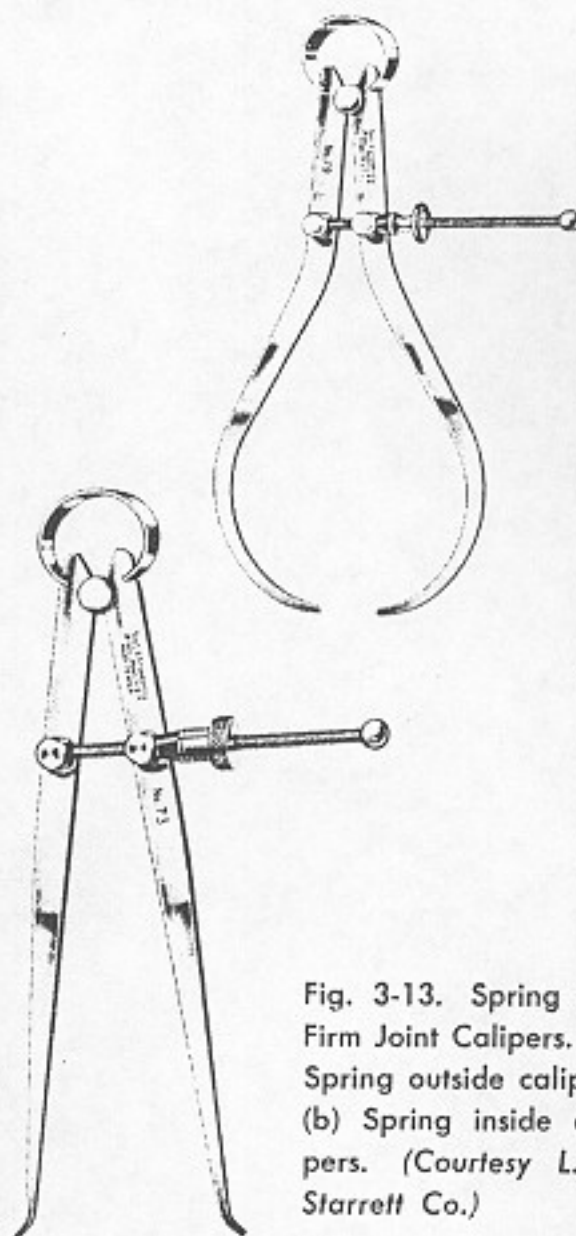
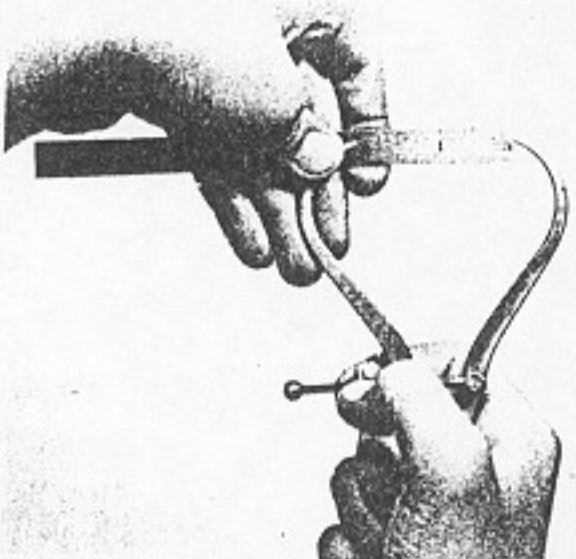
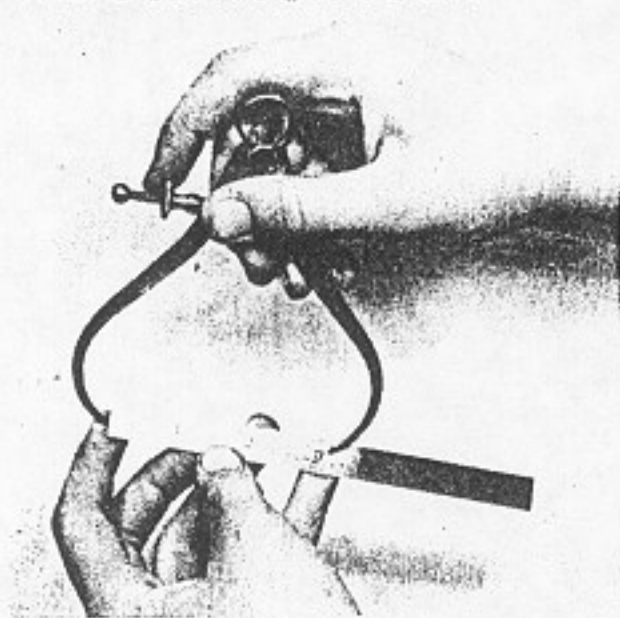


Fig. 3-13. Spring and Firm Joint Calipers. (a) Spring outside calipers. (b) Spring inside calipers. (Courtesy L. S. Starrett Co.)

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(a) Setting the calipers from a measurement to the end of the rule.



(b) Setting the calipers from the end of the rule to a measurement.

Fig. 3-14.

Using Inside Calipers to Determine Inside Measurements. To determine inside measurements, hold the spring joint of the inside calipers with the fingers of one hand. Then

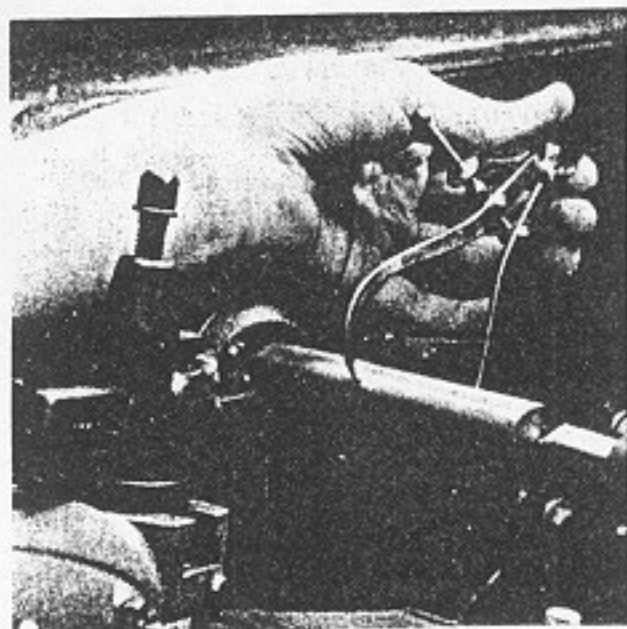


Fig. 3-15. Calipers are used for measuring diameters that can be measured in fractions of an inch, such as 64ths, 32nds, or 16ths.

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carefully slide the calipers into the opening being measured (see Fig. 3-17). (To measure an opening accurately, the calipers must be held in line with the hole.) Then carefully move the calipers in the opening while turning the adjusting nut until a very light touch of the legs against the metal is felt. The size of the hole is obtained by setting the caliper legs against a steel rule.

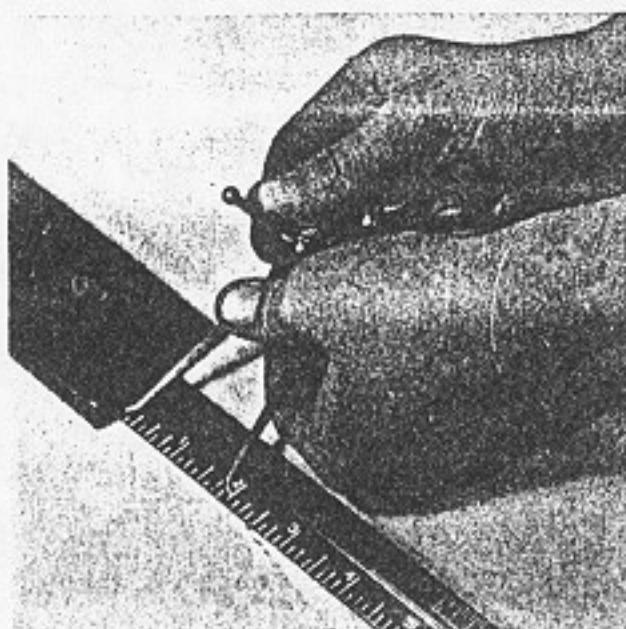


Fig. 3-16. Adjust the caliper leg to the center of the graduation on the rule.

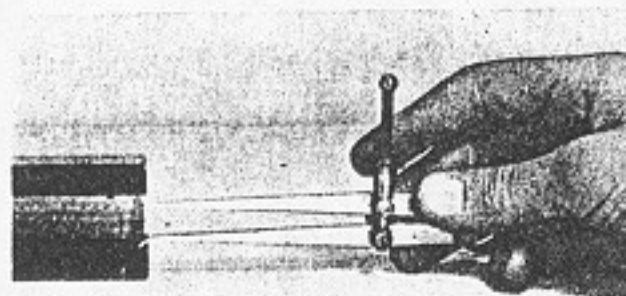


Fig. 3-17. The accuracy of measurements made with calipers depends on the sense of touch of the person using the calipers.

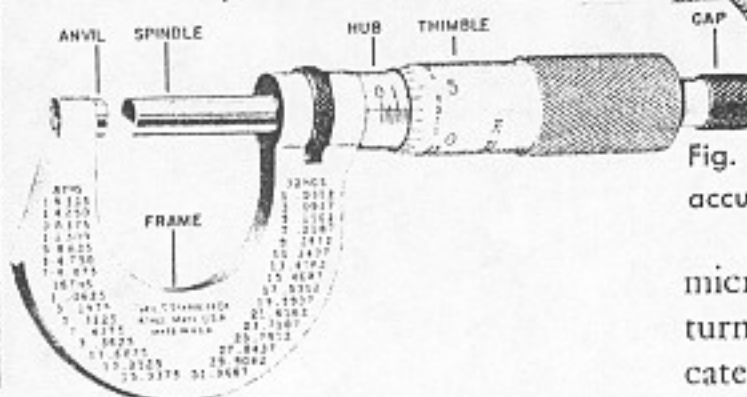


Fig. 3-18. Outside Micrometer. (Courtesy L. S. Starrett Co.)

Outside Micrometer

The outside micrometer (see Fig. 3-18) is a precision measuring instrument. It is used to make outside measurements in thousandths of an inch. To measure from zero to one inch, a one-inch micrometer is used. To measure from one inch to two inches, a one-inch to two-inch micrometer is used. Outside micrometers are made for measuring distances as great as 24 inches.

Using an Outside Micrometer to Measure Outside Surfaces. To measure with an outside micrometer, open it slightly wider than the metal being measured. Holding the micrometer with one hand (see Fig. 3-19), place the anvil against the object being measured. Turn the thimble with the thumb and forefinger of the hand holding the micrometer. When the spindle makes contact with the work, carefully adjust the thimble, at the same time making slight rotating movements of the micrometer. The micrometer has been properly adjusted when a light touch or drag is felt between the anvil, the spindle, and the work. Remove the

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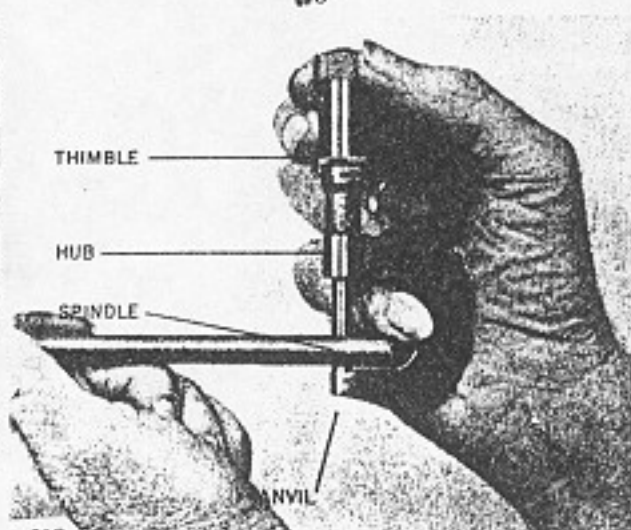
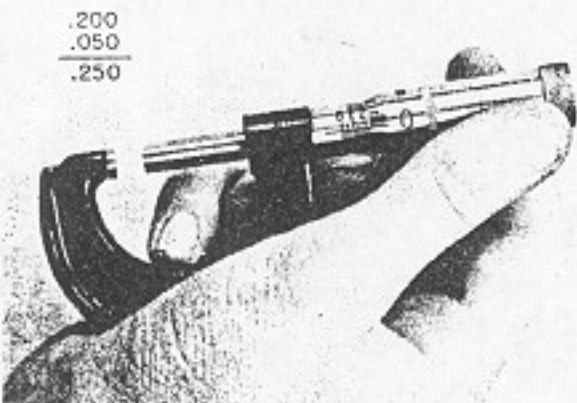


Fig. 3-19. Micrometers are used when very accurate measurements are necessary.

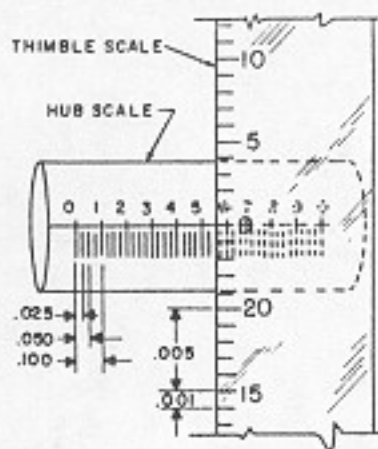
micrometer from the work without turning the thimble. The size is indicated by the exposed figures on the micrometer hub plus those shown on the beveled section of the thimble.

How to Interpret the Graduations on a Micrometer. The size of the work being measured with a micrometer is read from the lines and figures on the hub (see Fig. 3-20a). Every fourth graduation is numbered from 1 to 10. The figure 1 represents one hundred one thousandths of an inch (fraction $\frac{101}{1,000}$, decimal .100); the figure 2, two hundred one thousandths of an inch (fraction $\frac{201}{1,000}$, decimal .200). When the thimble is turned so that its edge is even with the first unnumbered graduation on the sleeve and the zero

mark on the thimble is in line with the long horizontal line on the hub, the micrometer has been opened .025 inch. When the thimble is turned to the second unnumbered line, a second .025 inch has been added to the first, making a total of .050 inch (see Fig. 3-20b).



(a) The micrometer is held in one hand so that the thimble can be turned with the thumb and one finger.



(b) The above micrometer scale is enlarged to show the line graduations, which can be read in thousandths of an inch. (Adapted from Hand Tools, Navy Training Course, U. S. Government Printing Office, 1944.)

Fig. 3-20.

The scale on the thimble is used almost exclusively in the United States when the edge of the thimble rests between line graduations on the hub. The

thimble scale is divided into 25 equal spaces; each space represents $\frac{1}{25}$ of a turn of the thimble or one thousandth of an inch (fraction $\frac{1}{1,000}$, decimal .001). For ease of reading, every fifth line on the thimble scale is numbered—5, 10, 15, and 20.

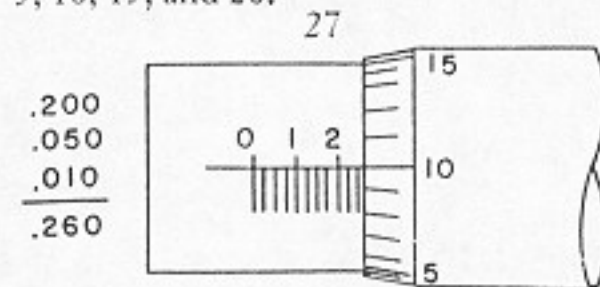


Fig. 3-21. Reading the micrometer scale to thousandths of an inch.

Reading a Micrometer Scale. To learn how to read a micrometer scale, first note that the highest number that can be seen on the hub in Fig. 3-21 is 2, or .200. Between this 2 and the edge of the thimble, there are two graduation lines on the hub. Each of these lines represents .025 inch, so together they represent .050 inch. Now count the number of lines on the thimble from 0 to the horizontal line on the hub. In the illustration, there are ten. Each of these lines represents .001 inch, so together they represent .010 inch. Now add the three figures together: .200 plus .050 plus .010 equals .260 inch. This is the reading of the micrometer scale in the illustration.

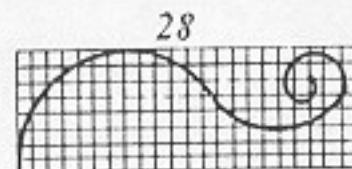
Gages for Wire and Sheet Metal

The American, or Brown and Sharpe, gage (see Fig. 3-22a) is used for measuring the diameter of wire and the thickness of nonferrous sheet met-

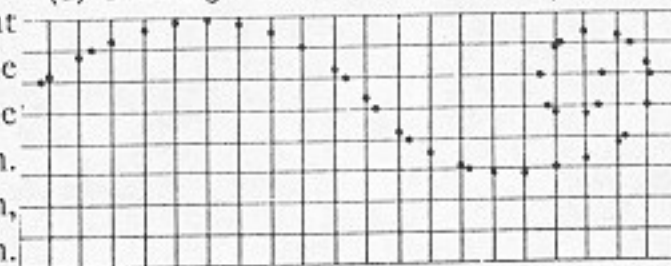
als such as copper, brass, and aluminum. However, another gage, the U.S. Standard Sheet Metal gage (see Fig. 3-22b) is used to measure the thickness of steel sheets and plates, such as galvanized iron, black iron, tinned, and terneplate.

Pattern or Template

Patterns, which are the same shape and size as the object to be made, save time and work when a large number of like pieces are to be made. The first piece is laid out on paper, wood, or sheet metal and then cut out to serve as a pattern. This pattern is then used to reproduce the layout for as many pieces as are needed. In sheet metal work, a pattern is often called a template.



(a) Drawing for a scroll to be duplicated.

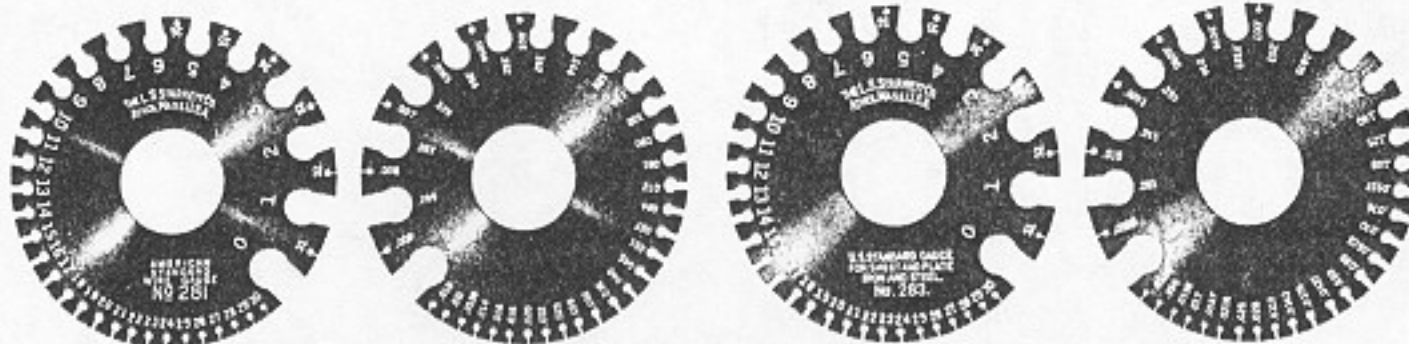


(b) Squares on paper or metal being used to enlarge the scroll by transferring points from the drawing to the enlarged squares.



(c) Connecting the points with a continuous line produces an enlarged scroll.

Fig. 3-23.



(a) American standard wire gage. (Courtesy L. S. Starrett Co.)

(b) U. S. standard sheet metal gage. (Courtesy L. S. Starrett Co.)

Fig. 3-22. Wire and Sheet Metal Gages.

Transferring Curves or Scrolls from a Drawing to a Piece of Metal. The drawing is usually made over lines forming small squares. To transfer curves or scrolls from such a drawing (see Fig. 3-23a) to paper or metal, first lay out the squares on the material to the full size as indicated on the drawing. The curve is transferred from the drawing to the material by pointing off on the squares (see Fig. 3-23b). After this, the several points are connected by a line to make the desired curve (see Fig. 3-23c).

Using a Pattern. The pattern must be held firmly on the metal. Begin by scribing a line around the pattern, keeping the point of the scribe against the edge at all times. Then, if there are locating holes in the pattern, with a scribe make marks on the metal through these holes. After removing the pattern, hold an edge of a steel rule or straightedge in alignment with the marks made on the metal through the holes in the pattern and scribe a line along the edge of the rule. These lines complete the layout on the metal.

Questions

1. What is the purpose of coloring a metal surface with a dye?
2. Name three uses of a steel rule.
3. Name three kinds of squares and explain their uses.
4. Why are prick punch marks made along layout lines?
5. What is laying out?
6. Name two types of calipers and explain the use of each.
7. What is a micrometer? Explain its use.
8. Explain the method used for enlarging or transferring scrolls or curves from a drawing onto a piece of metal.

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C H A P T E R 4

Cutting and Filing

This chapter covers the following subjects:

The Hand Hack Saw, 29 • Jeweler's Saw, 31 • The Cold Chisel, 33 • Tinner's Snips, 36 • Squaring Shear, 37 • Files, 37

A large number of tools have been developed for cutting metal by hand. The steel in a metal cutting tool must be harder than the metal to be cut; therefore, these tools are made of hardened steel. Such steel is made by mixing two or more kinds of metal to form an alloy that can be heat treated. Some very high grade cutting tools are made of alloy steel.

Steel that has been hardened by heat treating cannot be cut or worked with hand tools until it is softened by reheating and by slow cooling. This process is known as annealing.

The Hand Hack Saw

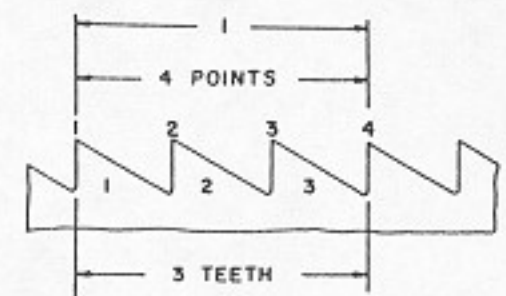
The hand hack saw is a very important metal-cutting tool (see Fig. 4-1). It is the tool the mechanic frequently uses to cut stock to size. In order to use the hack saw to good advantage, it is well to see how the tool is made. Some saw frames are solid and will hold a blade of one length only. This length is usually 10 or 12 inches. Other frames have an adjustable back, which can be moved to fit blades of various lengths (see Fig. 4-1).

Hand Hack Saw Blades. Hand hack saw blades are narrow, thin pieces

of steel with holes at each end and with teeth on one edge. The blade is usually held in the hack saw frame by being stretched taut by a wing nut and being placed on the two metal pins and screw arrangement. The size of the teeth varies according to the number of teeth per inch. There may be, for example, 14, 18, 24, or 32 teeth to the inch (see Fig. 4-2a). The teeth are set, which means that one tooth is bent toward one side of the blade and the next tooth is bent toward the opposite side of the blade. There are two types of sets in common use: the regular set and the wave set (see Fig. 4-2b). The set of the teeth enables the saw blade to cut a groove wider than the thickness

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saw from binding in the cut. Hack saw blades can be either flexible or stiff. Only the teeth on some saw blades are hardened; the rest of the blade is soft and flexible. Such a flexible blade will not break easily. The stiff blade has the cutting edge and entire body of the blade hardened. Such a blade is not flexible and is more easily broken. The blade is placed in the frame with the teeth pointing away from the handle, so that the cutting action takes place on the



(a) From the point of one tooth to the point of the next is one tooth. To determine the number of teeth per inch, count the points of the teeth for one inch.



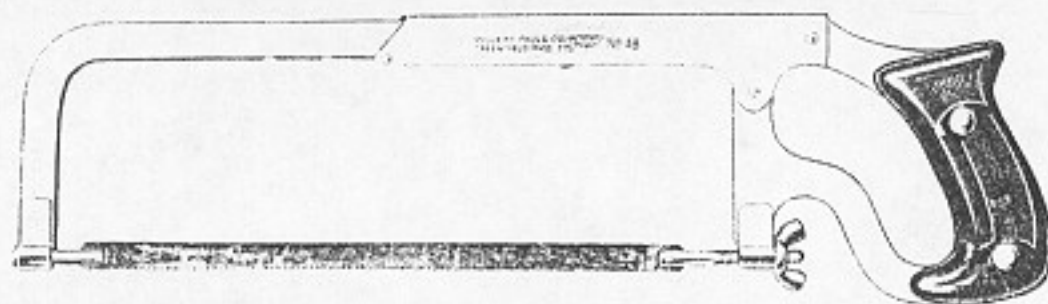
REGULAR SET



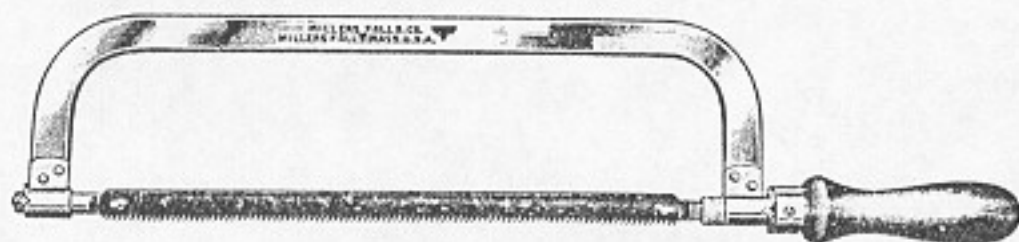
WAVE SET

(b) You will note the difference in the set of the teeth by comparing the two blades as shown in (b).

Fig. 4-2.



(a) Adjustable hack saw frame. (Courtesy Millers Falls Co.)



(b) The non-adjustable hack saw frame. (Courtesy Millers Falls Co.)

Fig. 4-1.

pushing stroke.

Selecting a Hack Saw Blade. The proper selection of the hack saw blade (see Fig. 4-3) makes the work of sawing metal easy and provides longer service from the blade. In general, thin metal and tubing require fine-toothed blades. Small teeth are not so easily broken. For cutting heavier sections, use a coarse-toothed blade.

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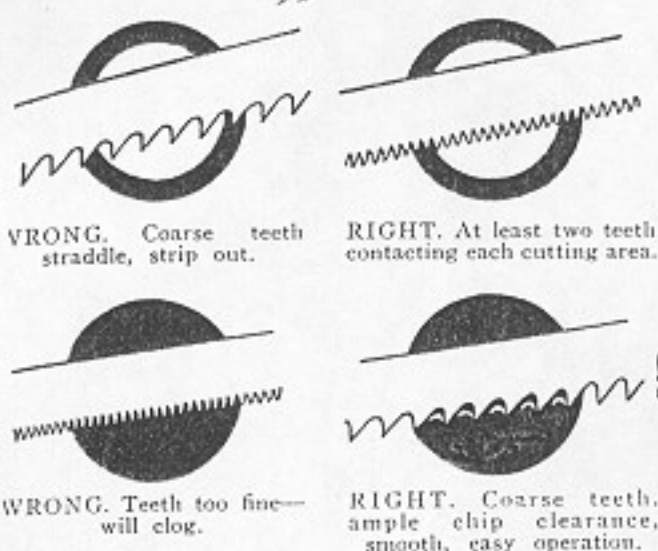


Fig. 4-3. A good mechanic is careful in his choice of a hack saw blade.

Using the Hand Hack Saw. Once the proper blade has been selected and placed in the hack saw frame, it should be tightened by turning the wing nut. Take several strokes and adjust the blade again to the proper tension.

It requires some practice to start the cut. The blade should be placed on the work in such a manner as to engage as

many teeth at one time as possible. If no wide area can be reached, as is the case with thin metal or tubing, continue the cut with easy, light strokes. Sometimes it is possible to clamp the metal between two pieces of wood in the vise to make the piece more rigid.

Sawing the Metal. Metal is usually held in a vise while it is being sawed. The layout line along which the cut is to be made should be as close to the vise jaw as possible. The operator should stand in a natural, easy position at the vise. He should then place the hack saw blade on the metal just outside the layout line, push the hack saw forward, and apply just enough pressure to cause it to start the cut (see Fig. 4-4). The

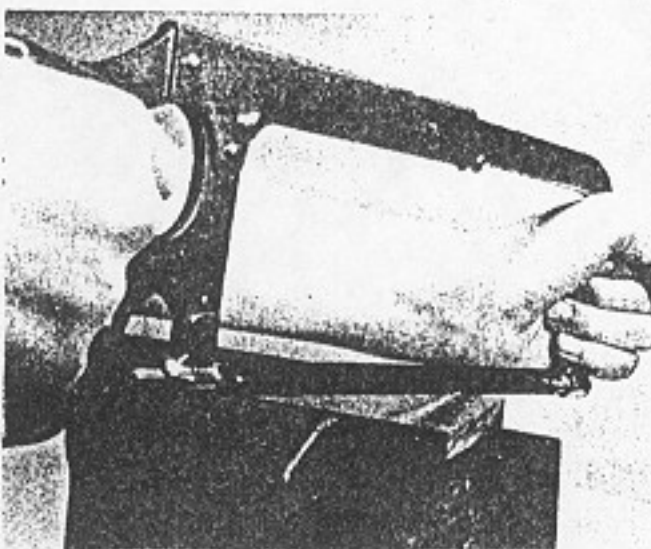


Fig. 4-4. Use less pressure on the saw when the cut is about through the metal.

operator should continue sawing with a light pressure until the cut is well

started. He should not use a rapid, jerky motion, but should push the saw back and forth regularly, taking a full stroke; in other words, cut the full length of the blade at about 60 strokes a minute.

Jeweler's Saw

Many of the things you have learned about a hack saw can be applied to a jeweler's saw, which is a much more delicate tool. Graceful curves often improve the appearance of articles made of metal. To saw these curves, a jeweler's saw is used. It is made with a metal frame, to which a round handle

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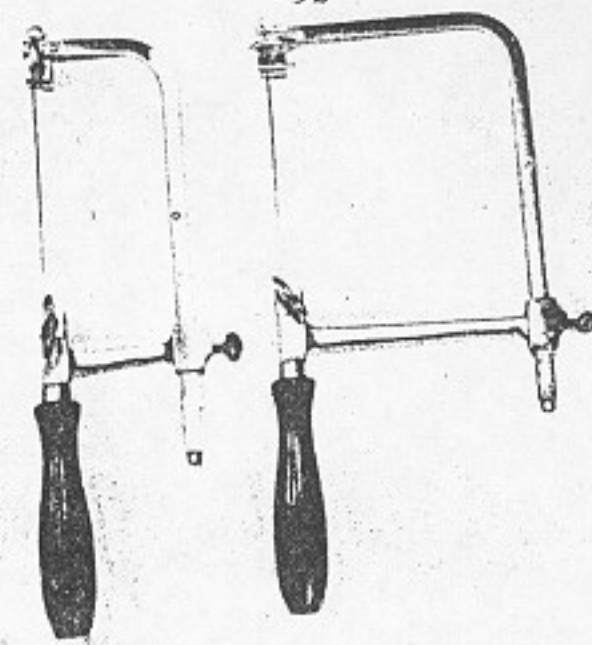


Fig. 4-5. The Jeweler's Saw.

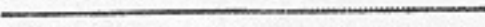
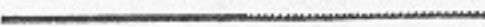
is attached (see Fig. 4-5). To hold the blade in the frame, a clamping device that is tightened with a wing nut is a part of each end of the C-shaped frame. Since the saw blade is not part of the saw frame, there must be some means provided for tightening or loosening the blade once it is clamped into the frame. This is done by loosening a wing nut on the saw frame, adjusting the frame until the blade is stretched taut, and tightening the wing nut again.

Jeweler's Saw Blades. Jeweler's saw blades are used to saw soft, non-ferrous metals. They are made in a great many sizes (see Fig. 4-6). The size is designated by a number, such as 4/0, 0, 1, 1½, and so on up to 14. The smaller the number is, the finer the teeth and the narrower the blade. The

blade to be used is determined by the thickness or gage of the metal. If sharp curves are to be followed, a narrow blade is required.

Using a Jeweler's Saw. To use a jeweler's saw, first select the proper blade for the kind and gage of metal to be sawed; for most work the number 2 blade is satisfactory. Then, clamp the blade tightly in the saw frame. The teeth should be pointing toward the handle, for the cutting is done only when the blade is being pulled downward, which is just opposite to the way a hack saw is used. The metal should be held firmly on the flat surface of a wooden V-board (see Fig. 4-7) or held in a vise.

Hold the saw in a vertical position (see Fig. 4-7). With a light pressure and a slow, easy stroke, pull the saw downward, applying just enough pressure so that the saw will cut. No pressure should be applied on the return or upward stroke. While you are sawing, follow curves by turning the metal or the saw frame. Great control should be exercised while sawing, for the blade

Sizes	Saw Blades
4/0	
3/0	
2/0	
0	
1	
1 1/2	
2	
3	
4	
5	
6	
8	
10	
12	
14	

Saws Finer Than 4/0 Not Illustrated

Fig. 4-6. For most work the number 2 jeweler's saw blade is satisfactory. (Courtesy William Dixon, Inc.)

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of a jeweler's saw is very thin and breaks easily.

Piercing. Most sawing is done from the outside edge of a piece of metal. In piercing, however, you saw from the inside of the metal, not from the outside edge. To do this, drill or

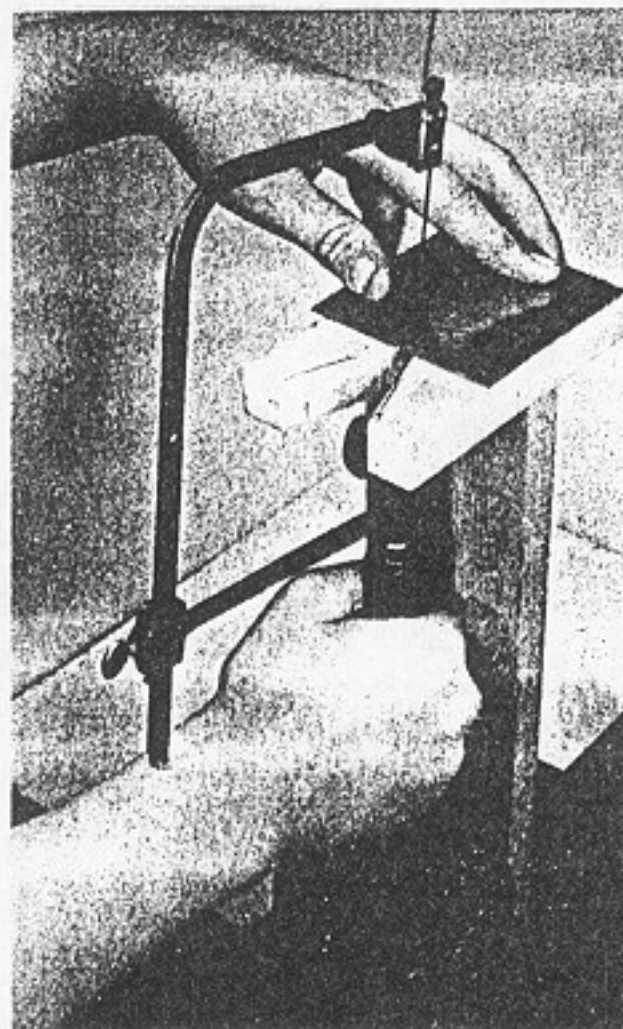


Fig. 4-7. When using a jeweler's saw, be very careful or you will break several of the fine, thin saw blades.

punch a hole, insert the saw blade in it, and clamp the blade in the jeweler's saw frame. You may then saw out the design, following the same procedure as when using the jeweler's saw for any other work.

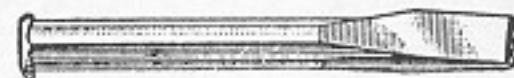
The Cold Chisel

A cold chisel is used for the cutting and chipping of metal. It is a metal cutting tool with one end hardened and ground to the shape of a flat wedge (see Fig. 4-8). The opposite end is left a little softer because a hammer is used to strike blows on this end of the chisel. The cutting action of a cold chisel is the driving of the wedge-shaped cutting edge into the metal through the force of hammer blows. As the chisel is driven into the metal, chips are raised and broken off. This is what is commonly called chipping. Cold chisels are made in many shapes; however, the flat chisel is the mechanic's all-purpose tool. The cape, the round nose, and the diamond point are other frequently used types (see Fig. 4-8).

Grinding a Cold Chisel. After a cold chisel has been in use, the head becomes mushroomed from being hit with a hammer and the cutting end becomes dull or nicked (see Fig. 4-9a). The cold chisel should never be used in this condition. To sharpen a cold chisel, hold the cutting end at the correct angle against the face of a grinding wheel (see Fig. 4-9b) and move the chisel back and forth across the face of the wheel. Do not press the chisel hard or hold it too long against the grinding wheel, for too much pressure will cause the metal to become too hot, thereby removing the hardness from the cutting edge. While grinding, dip the cutting edge of the chisel in water often to keep it cool. Chisels with the cutting edge ground square with the sides as shown (see Fig. 4-8a-1)

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are satisfactory for light work and for finishing surfaces, but the corners will break off when the tool is used for large or heavy cutting. The breaking of the corners can sometimes be prevented by grinding the chisel slightly rounded (see Fig. 4-8a-3). Fig. 4-9c shows a cold chisel properly ground and ready for use. The most commonly used angle is from 60 to 70 degrees.

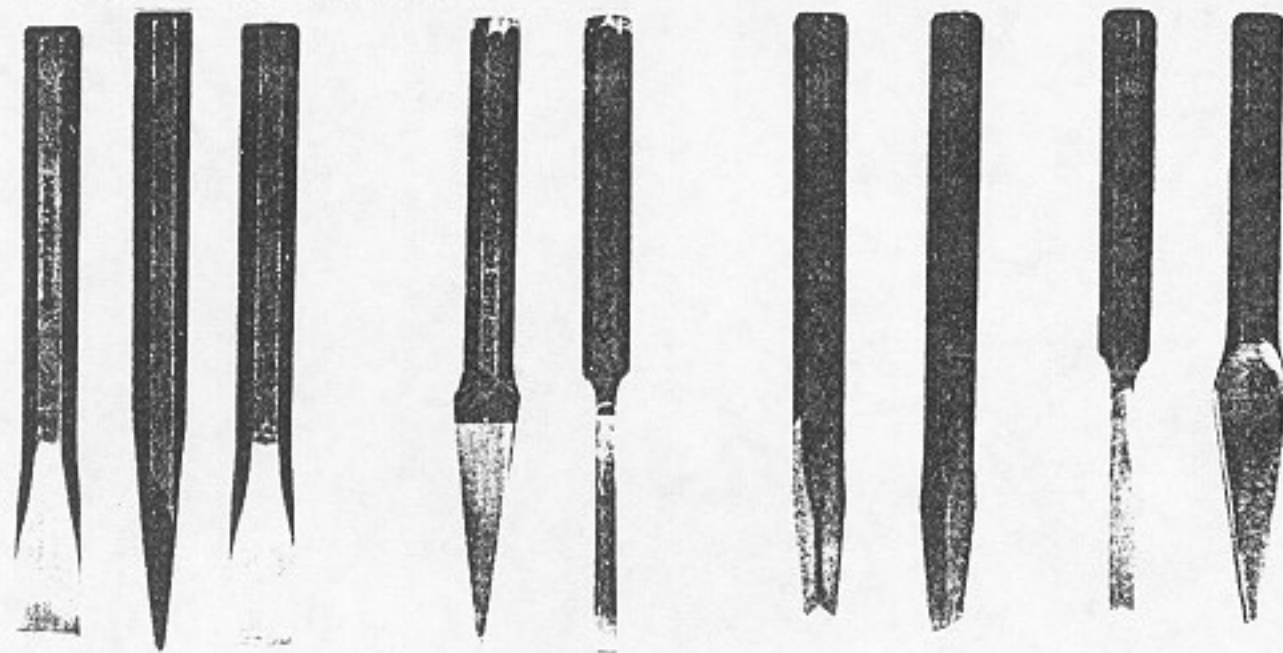


(a) Chisel with mushroomed head and dull cutting edge.



(b) Correct position of chisel for grinding.





(a) Flat cold chisel. (b) Cape chisel. (c) Diamond point chisel. (d) Round nose chisel.

Fig. 4-8. There are four common shapes of cold chisels in use today. All but the flat chisel have been designed for special work.

(c) Correctly ground cold chisel, showing correct angle of cutting edge.

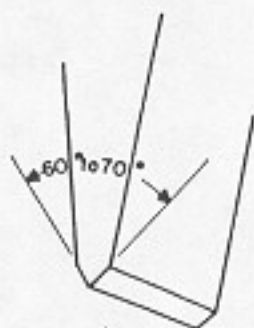


Fig. 4-9. Always wear goggles when grinding a cold chisel. They are a safeguard against a piece of metal's flying into your eyes.

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Using a Flat Cold Chisel to Chip in a Vise. Most chipping with a cold chisel is done with a 1- to 1½-pound machinist hammer. Grip the hammer handle close to its end. Grasp the chisel firmly near the head in the palm of the hand (see Fig. 4-10). Do not grip it too tightly. Hold the cutting edge of the chisel on the work where the cut is to begin. The angle at which the chisel is held will control the depth of the cut being made. Raising the head of the chisel will cause the chisel to cut deeper. Lowering the head of the chisel will cause it to remove less metal. After each blow of the hammer, the cutting edge of the chisel should again be placed in position on the cutting line.

Watch the cutting edge, not the head of the chisel, when chipping. With a little practice, you will be able

to hit the chisel squarely with the hammer. It is a good, safe practice to wear goggles when chipping.

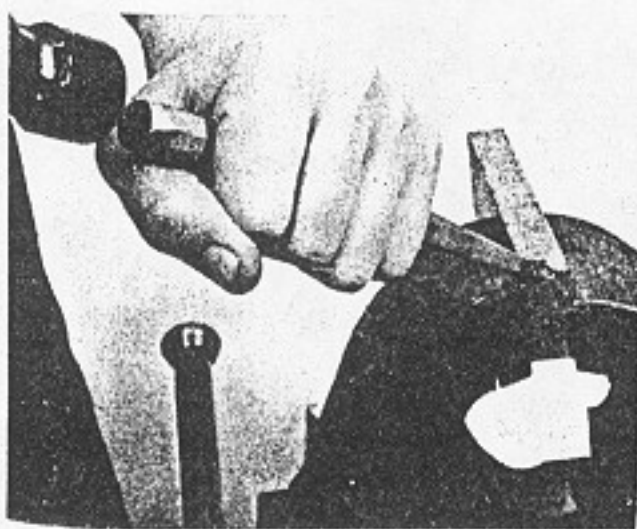


Fig. 4-10. When chipping metal, always be sure no one is directly in front of you, as the chips can cause injury.



Fig. 4-11. Only metal that is thin and narrow enough to be held in a vise can be sheared with a cold chisel at a vise.

Using a Flat Cold Chisel to Shear Thin Metal in a Vise. To shear thin metal, grip it in a vise with the cutting line of the metal even with the top of the vise jaw. Hold the chisel on top of the vise jaw at about a 30-degree angle to the metal. The bevel, which forms the cutting edge of the cold chisel, must move along the vise jaw. Strike the chisel with a hammer (see Fig. 4-11). Slide the chisel along the metal, keeping it on top of the vise jaw. Strike the chisel again and continue until the metal has been sheared.

Using a Cold Chisel to Cut Metal. The cold chisel can be used to cut metal by placing the metal on a solid surface such as a pounding block or anvil. Place the cutting edge of the chisel on the metal at the location of the cut (see Fig. 4-12). With a hammer strike the chisel one sharp, hard blow. Move the chisel forward along the layout line, overlapping the cut just made, and strike the chisel again. Continue until the metal is cut.

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Fig. 4-12. Wide pieces of metal that are too heavy to be cut with tinners' snips can easily be cut with a cold chisel.

Tinners' Snips

Sheet metal is usually hand cut with tinners' snips, which resemble a pair of very heavy, strong scissors (see Fig.

4-13). Objects made of sheet metal must be laid out or the design transferred onto the sheet metal from a pattern. Tinnners' snips are used to cut along these layout lines. Tinnners' snips with straight blades are used to cut along straight lines and outside curved lines; snips with curved blades are used for inside curves.

Using Tinnners' Snips for the Cutting of Sheet Metal. Tinnners' snips are used in about the same way as a pair of scissors. Each cut should be about one-half to three-quarters the length of the cutting blades (see Fig.

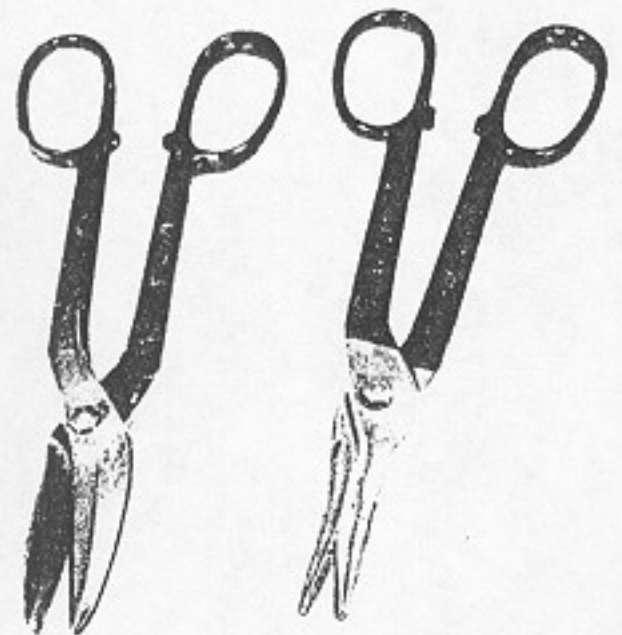


Fig. 4-13. Tinnners' snips.

4-14). For the next cut, open the tinnners snips slowly, while pushing them forward and against the metal. Be sure the second cut is started in exactly the same place where the other cut left off. By repeating this process, one can cut a clean, straight line. If a cut ends on an intersecting layout line, stop cutting

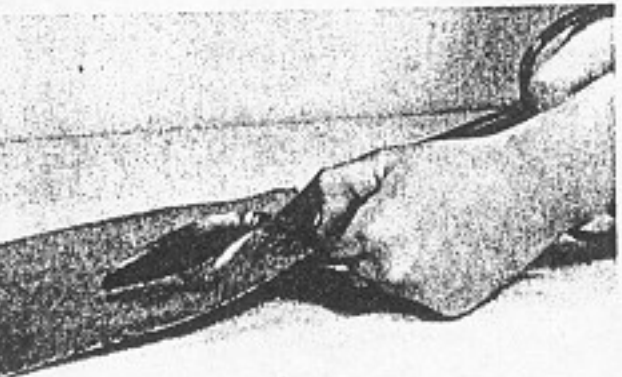


Fig. 4-14. When cutting with tinnners' snips, be careful that no small, sharp, needle-like points are left along the edge being cut. These can cause very painful injuries.

approximately one-half inch from the line. Start a new cut, slowly and carefully cutting the remaining half inch of the metal. Be very careful not to cut beyond the intersection of the layout lines, for there is no way to correct the mistake.

Squaring Shear

The purpose of the squaring shear (see Fig. 4-15) is to cut one straight edge on a piece of sheet metal. To cut the metal with a squaring shear, the operator presses a foot pedal.

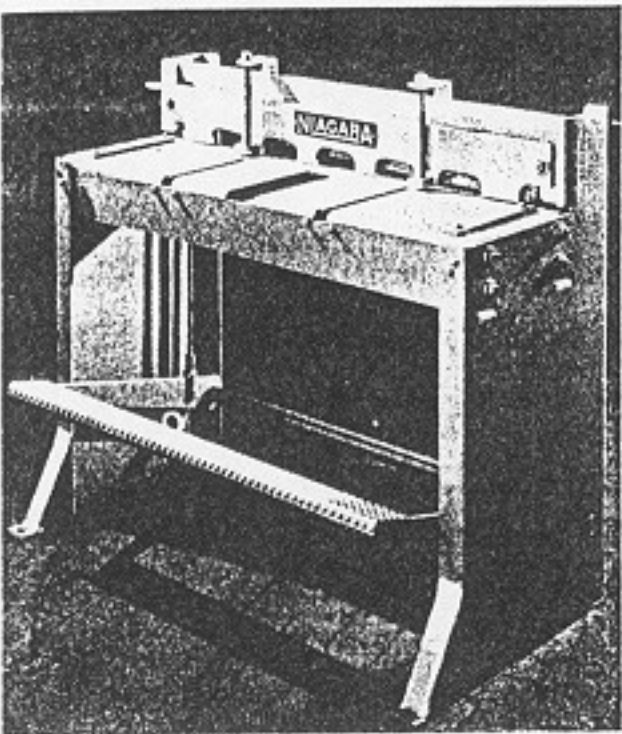


Fig. 4-15. Squaring Shear. (Courtesy Niagara Machine and Tool Works.)

Files

Files are important metal working tools. An assortment of different shapes and sizes will be found in the tool boxes of all good mechanics. They are made of hardened steel and are used for the removal of burrs and for the accurate finishing of metal surfaces. The file is used frequently in the final fitting of metal parts. In filing, a small amount of metal is removed with each stroke of the file. A person skilled in the use of a file can shape a piece of metal to close dimensions. Files are classified, according to their shape (see Fig. 4-16), as flat, three-square or triangu-

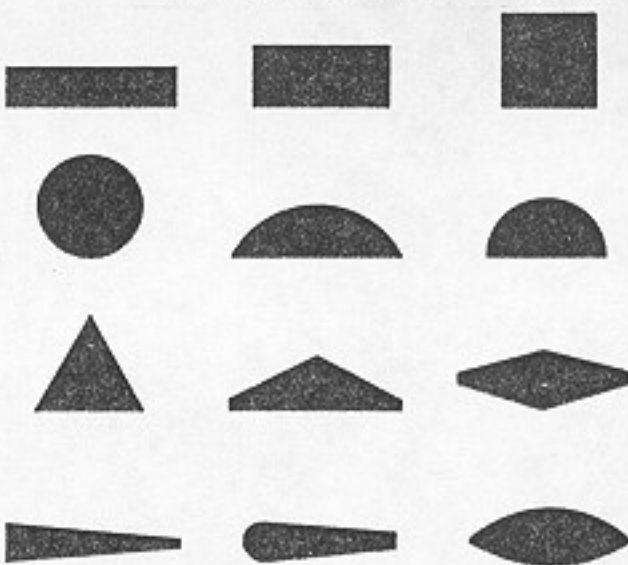


Fig. 4-16. File Shapes. (Courtesy Nicholson File Co.)

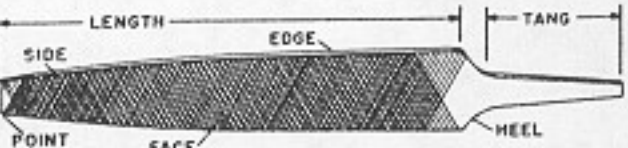


Fig. 4-17. Names of the parts of a file. lar, square, round, and half round. Other shapes are made to serve highly specialized purposes and are listed as miscellaneous shapes by the manufacturers.

The long, narrow, pointed end of the file onto which the handle is fastened is known as the tang (see Fig. 4-17). The length of files is measured from the end or point of the file to the base of its tang or heel.

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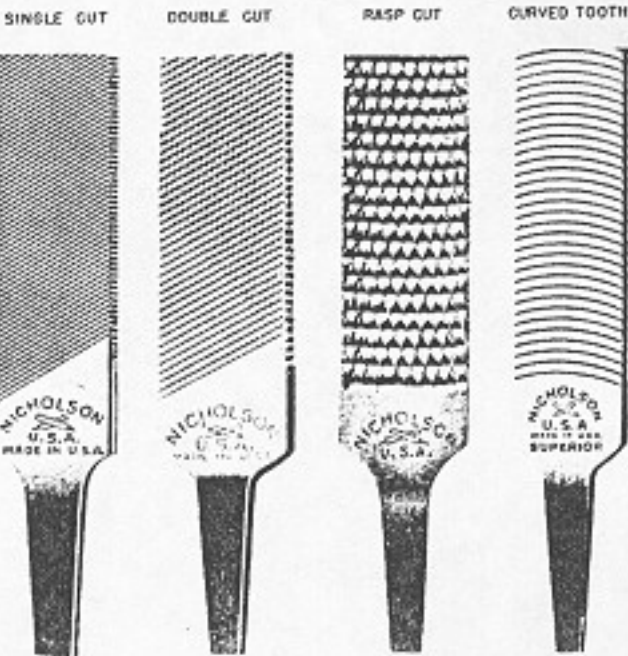


Fig. 4-18. The cut of a file determines the kind of work it should do. Fine cut files are used for smooth filing, coarse cut files for rough, fast filing. (Courtesy Nicholson File Co.)

The cut of a file is most generally referred to as single cut, double cut, rasp cut, and circular cut (see Fig. 4-18). The cut of a file forms teeth or cutting edges that can be made to various degrees of coarseness, ranging from rough to smooth. The four most common degrees of cuts used in metal work are the single cut, the double cut, second cut, and the circular cut.

The double cut file cuts or removes metal more rapidly than the single cut file. For this reason, it is used for roughing or the quick removal of surplus metal. The single cut file cuts slowly and is used for finish work. This file would be used to work down to a layout line after the double cut file had removed most of the surplus metal. The curved tooth file is usually used for filing soft metals like aluminum and lead. Files must be harder than the metal to be filed, for otherwise the cutting edges of the file would be nicked or dulled quickly. Files should never be thrown together, nor should the cutting edges of one file be rubbed against another file.

Files today are made in many different sizes, shapes, and cuts. The following ones are those most commonly in use. The flat bastard file (Fig. 4-19a) is a double cut file. The shape of the teeth makes it a fast, rough file for removing metal. It is used on flat surfaces where a considerable amount of metal is to be removed and a smooth finish is not necessary. A mill file (Fig. 4-19b) is a single-cut file. The shape of the teeth causes this file to produce a fine, smooth surface. It is used for sharpening cutting tools that are not harder than the file, for filing lathe work, for draw filing, and for finish filing to a layout line. The hand finishing file (Fig. 4-19c) is a fine, double cut file, excellent for draw filing and for the finishing of flat, smooth surfaces. Half round files (Fig. 4-19d) are double cut. The half round surface is used for filing concave surfaces or inside diameters. The flat side is used as a flat bastard file. Square files (Fig.

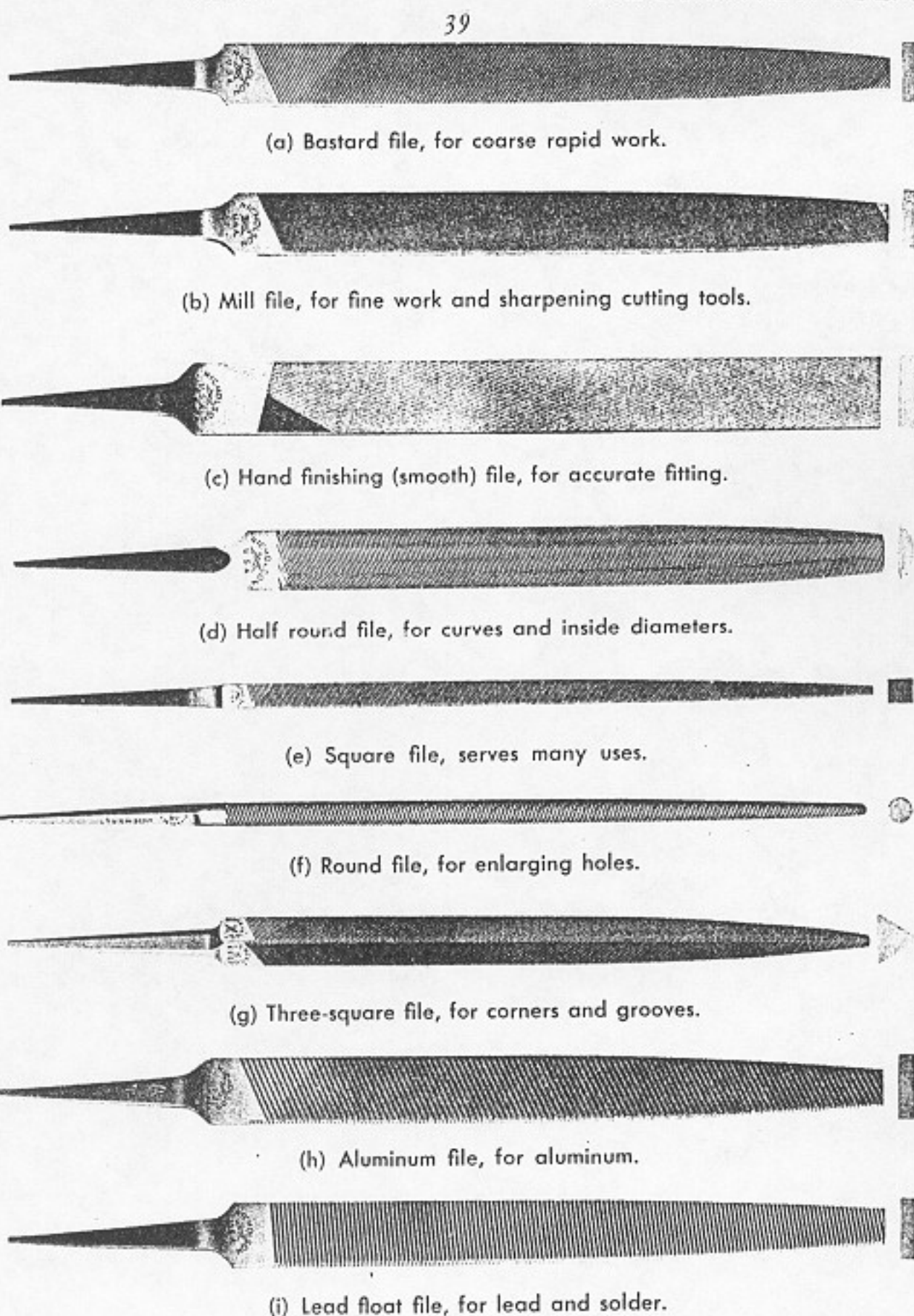


Fig. 4-19. The more common files in use today. (Courtesy Nicholson File Co.)

4-19e) are double cut and are generally made tapering so that the square is larger near the tang or handle end of the file than at the point. This file has many uses, because all four sides can be used for filing. Round files (Fig. 4-19f) are often called rat-tail files. They are tapered like the square file. Their widest use is in enlarging holes. Three-square files (Fig. 4-19g), often

called triangular or three-cornered files, are used for filing square corners and V-shaped grooves. Aluminum files (Fig. 4-19h) are made in both flat and half round shapes. They are designed for filing soft metals, such as aluminum. Lead float files (Fig. 4-19i), which are made in both flat and half round shapes, are designed for filing lead and solder.

Using a Flat File When Cross Fil-

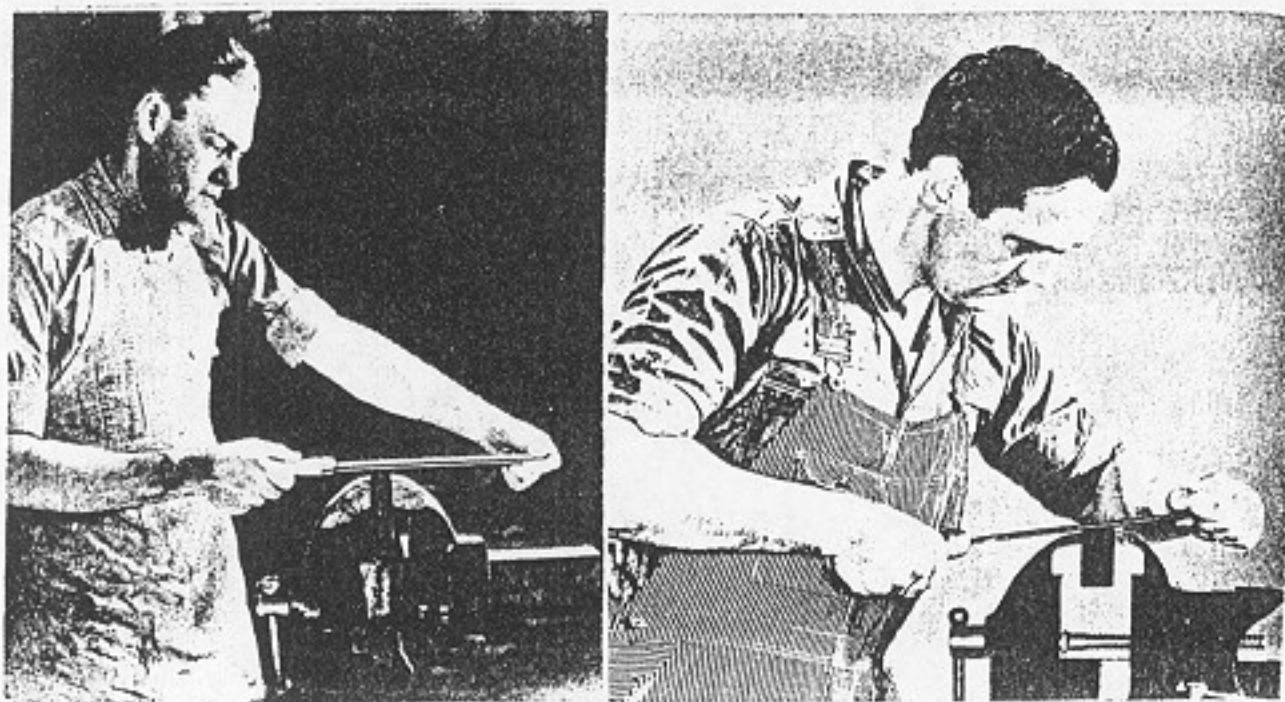


Fig. 4-20. The right way to file is the easy, accurate way, as shown at left; the wrong way, as shown at right, is difficult and produces inaccurate work. (Courtesy Nicholson File Co.)

ing. To cross file, hold the handle of the file in the right hand and the point of the file by the thumb and the first two fingers of the other hand. Stand in a natural, easy position at the vise while pushing the file across the metal (see Fig. 4-20a). Keep the file level while pushing it across the work by applying more pressure with the left hand at the start of the stroke. As the file progresses across the work, the left hand pressure is diminished and additional pressure is applied by the right hand. Since the file cuts only on the forward stroke, it should be lifted on the return stroke. Common faults of cross filing are rocking the file (see Fig. 4-20b) and not filing on a level plane, producing a rounded or convex surface instead of a flat, straight surface. After cross filing, finish file with a mill or smooth file.

Draw Filing. Draw filing consists of holding the file at right angles to the work. Hold the handle or tang end of the file in the left hand as you draw the file along the metal toward yourself. An alternate method is to hold the tang end of the file in the right hand and to push the file along the metal away from yourself (see Fig. 4-21). Very smooth

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work may be done by draw filing. A mill file or hand finishing file is best

suited for draw filing. The file should be cleaned often when draw filing.

Using a File to Square the End of a Piece of Metal. To square the end of a piece of metal, scribe a line square across the end of the metal to be squared and then prick punch along the entire length of the line. Grip the metal in a vise with the layout line close to the vise jaws. Hold the file flat on the metal, square with one side and one edge. Push the file across the metal, applying just enough pressure to cause the file to cut. Raise the file off the metal on the return stroke. Push and return the file several times. Check the

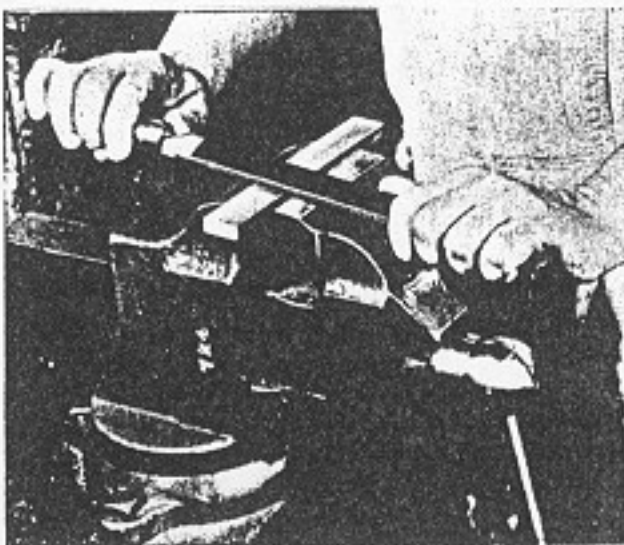
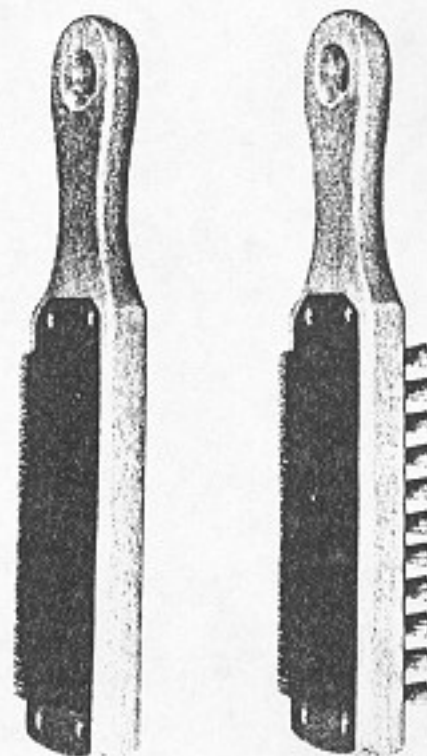


Fig. 4-21. Do not push and pull the file back and forth along the metal, as the filings will stick in the teeth of the file and cause deep scratches in the surface being filed. (Courtesy Nicholson File Co.)

metal for squareness by comparing the prick punch marks with the filed surface. Continue filing and checking until the end of the metal is square. The end is square when the top half of the prick punch marks have been filed away. This is called splitting the layout marks. A bastard file is used for the rough filing. Finish file with a mill or smooth cut file.

Using a File to Make an Edge of Metal Straight. To file an edge straight, it is best first to check the edge for straightness. After the edge has been checked, hold the metal to be filed in a vise. Remove the high spots with a file, which should be held as nearly parallel to the sides of the metal as possible. Again, check the edge for straightness and file again if necessary. Continue checking and filing until the edge is straight. A bastard file generally is used to remove the high spots, and the final filing is done with a mill or smooth file.

File Handles. Files are made and designed for use with a handle, which should fit the file being used. If a large, heavy file is used, a large handle is necessary. The tang of the file is fitted into the hole drilled in the small end of the



(a) File card.

(b) File brush.

Fig. 4-22. File Cleaners. (Courtesy Nicholson File Co.)

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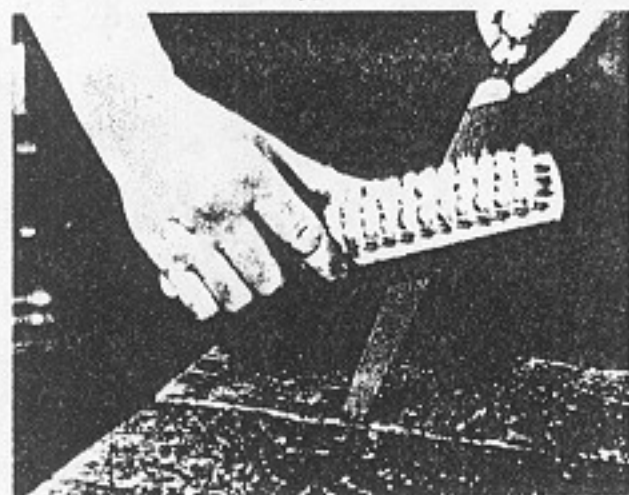


Fig. 4-23. Filings that are left in a file will scratch the surface of the metal being filed. For this reason a file should always be kept clean. Always brush across the file, never lengthwise of the file. (Courtesy Nicholson File Co.)

handle. *Safe practice requires the use of a handle at all times.*

File Cleaners. File cleaners are made in two styles (see Fig. 4-22), the file card with scorer for general use and the file brush, which combines a brush, card, and scorer. The latter style is generally used on finer cut files.

Using a File Brush, Card, or Scorer to Clean a File. A file brush or card is used to remove the filings that collect between the teeth of a file during the removal of metal. Frequent brushings across the file teeth with the brush or card will remove most of the filings (see Fig. 4-23). Often, filings will fill up and stick between the file teeth. These spots of metal are known as pins. They are removed or picked out of the file with a scorer, which is a piece of soft iron or brass wire that is generally attached to the file brush or card.

Questions

1. Are all hack saw blades alike? If not, explain how they differ.
2. How does the jeweler's saw differ from a hack saw?
3. Explain the reason for wearing goggles when chipping metal with a cold chisel.
4. Why is one end of a cold chisel soft?
5. What is a double cut file? Explain its use.

6. What is a single cut file? Explain its use.

7. What is the difference between cross

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filing and draw filing?

8. What is a file card?

C H A P T E R

5

Taps and Dies

This chapter covers the following subjects:

Kinds of Threads, 43 • Hand Taps, 43 • Tap Wrench, 44 • Dies, 45 • Die Stock, 46

Kinds of Threads

The four most common types of screw threads (see Fig. 5-1) are the V-thread, the National Form thread, the Square thread, and the Acme thread. Of the four types, the National Form thread is the most generally used. It is made with either a fine or a coarse thread. Coarse threads are used for ordinary fastenings, whereas fine threads are used in finely machined parts, such as automobile parts.

Threads may be either right-handed or left-handed. A tap (see Fig. 5-2) is used to cut the threads in a drilled hole. A die (see Fig. 5-3) is used to cut threads on a bolt. The number of complete spirals per inch is the number of threads per inch (see Fig. 5-4).

The size of a tap or die is always stamped on it. For example, the notation $\frac{3}{8}$ -16 NC stamped on either a tap or a die means it will cut a thread $\frac{3}{8}$ inch in diameter, with 16 threads to the inch, and the threads will be National Coarse (or, if NF, National Fine).

Drill Sizes for Cutting Threads with a Tap. A tap (see Fig. 5-2) is used to cut threads on the inside of a hole. Therefore, a hole must be made before threads can be cut with a tap. Since taps are made to standard sizes, the hole into which threads are to be cut must be drilled according to the size of the tap to be used. Because most

holes in metal are drilled, it is only logical that a drill of the correct size must be used for each different size of tap. These different drill sizes can be secured from any machinery handbook. To help you, some of the tap drill sizes are given in Table 2.

Hand Taps

There are three different styles of taps (see Fig. 5-2) in general use: the taper tap, the plug tap, and the bottoming tap. As their names imply, they are intended for different purposes. The

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TABLE 2

TAP DRILL SIZES FOR NATIONAL COARSE AND NATIONAL FINE THREADS

Size of Tap	Threads per Inch		Tap Drill Size	
	NC	NF	NC	NF
6	32	40	#36	#33
8	32	36	#29	#29
10	24	32	#25	#21
12	24	28	#16	#14
$\frac{1}{4}$	20	28	#17	#3
$\frac{5}{16}$	18	24	$\frac{1}{4}$ (F)	1
$\frac{3}{8}$	16	24	$\frac{5}{16}$	Q
$\frac{7}{16}$	14	20	#14	#14
$\frac{1}{2}$	13	20	#14	#14

taper tap is the one most generally used in the general metal shop.

Tap Wrench

A tap wrench holds taps for turning when you are cutting internal threads. There are two types of tap wrenches

(see Fig. 5-5): the adjustable tap wrench for large taps and the T-handle for small taps and for use in restricted areas.

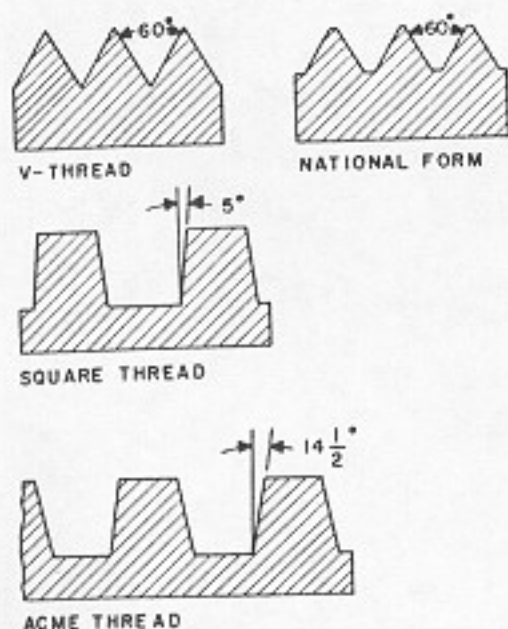


Fig. 5-1. Forms of Common Screw Threads.

Using a Tap to Cut Threads on the Inside of a Hole. To make sure that you are using a drill of correct size for the tap, consult Table 2. After selecting the drill, drill a hole in the metal (see Fig. 13-15, p. 153). Insert the tap in the hole. Then turn the tap slowly two or three turns while bearing down on the handles of the tap wrench (see Fig. 5-6a). After one or two threads have been cut, check to see if the tap is entering the hole straight up and down. Fig. 5-6b shows one method of checking for squareness. The tap should be tested for squareness on at least two sides. If it has not been started square, back the tap out of the hole a few turns and correct the position by applying a sidewise pressure on the tap wrench while again turning it into the hole. Again, check to see if the tap has been started square with the surface of the metal. After it has been

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started square, the tap must not be forced too rapidly. It is a good plan to turn the tap forward about a quarter turn, then back it off a little and repeat the forward turn. A lubricant, such as cutting oil or a mixture of white lead and oil, should be used liberally when cutting threads. Continue the

forward and backward turns until the threading has been completed.



(a) Taper tap, for any drilled hole.

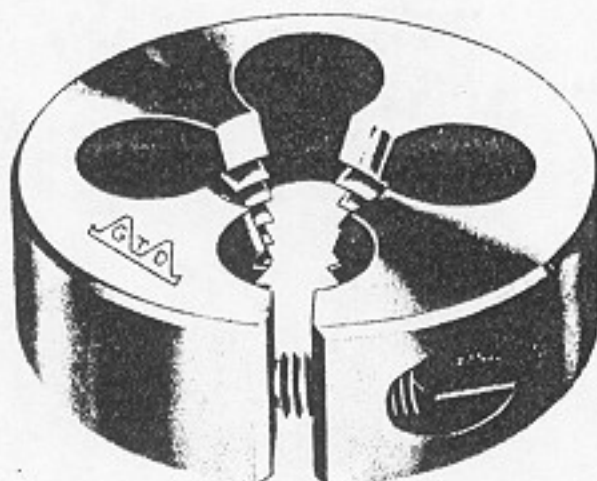


(b) Plug tap, for blind hole.

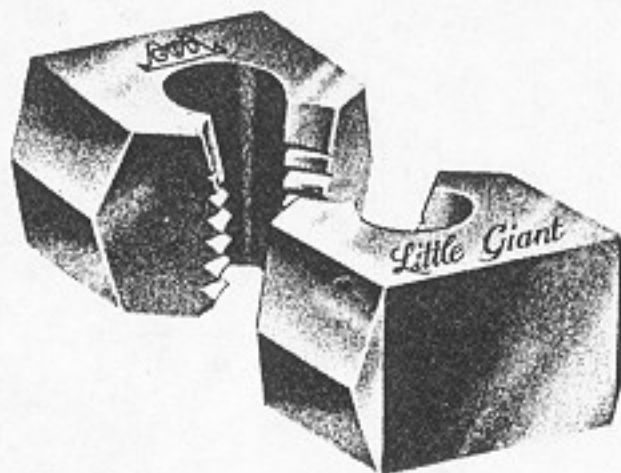


(c) Bottoming tap, for finishing threads to bottom of blind hole.

Fig. 5-2. Hand Taps. (Courtesy Greenfield Tap & Die Corp.)



(a) Round adjustable die.



(b) Adjustable die.

Fig. 5-3. Dies. (Courtesy Greenfield Tap & Die Corp.)

Dies

A die (see Fig. 5-3) is used to cut

threads on the outside of a bolt or a rod. There are two different styles of dies in general use, the round adjustable die and the two-piece die.

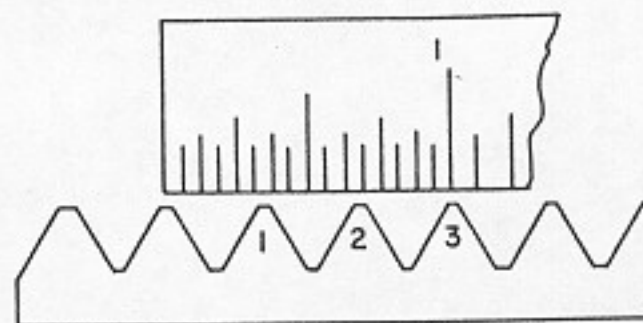
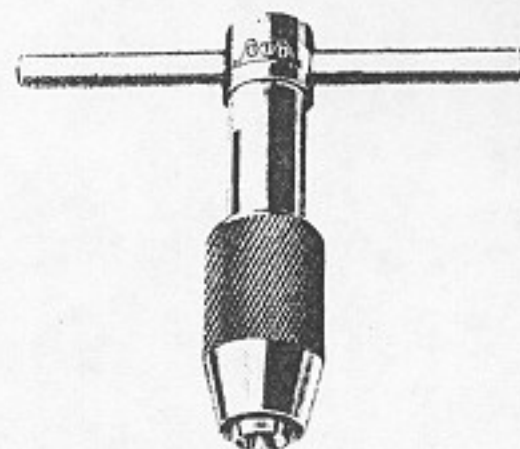
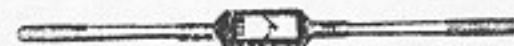


Fig. 5-4. From the top of the thread touching the end of the rule to the top of the next thread would be one thread. Counting for the rest of an inch would give the number of threads to the inch. In the illustration it would be three threads to the inch.



(a) T-handle tap wrench.



(b) Straight handle tap wrench.

Fig. 5-5. Tap Wrenches. (Courtesy Greenfield Tap & Die Corp.)

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Adjustable Die. The round adjustable die (see Fig. 5-3) is circular in shape, with a split from the edge to the opening in its center. By turning the adjusting screw you can make the die cut a slightly larger- or smaller-diameter thread. Thus it is possible to obtain either a tight- or a loose-fitting thread.

Two-Piece Die. The two-piece die (see Fig. 5-3) is made in two separate pieces. These pieces must be placed in a die stock designed to hold them. They are then adjusted to cut the

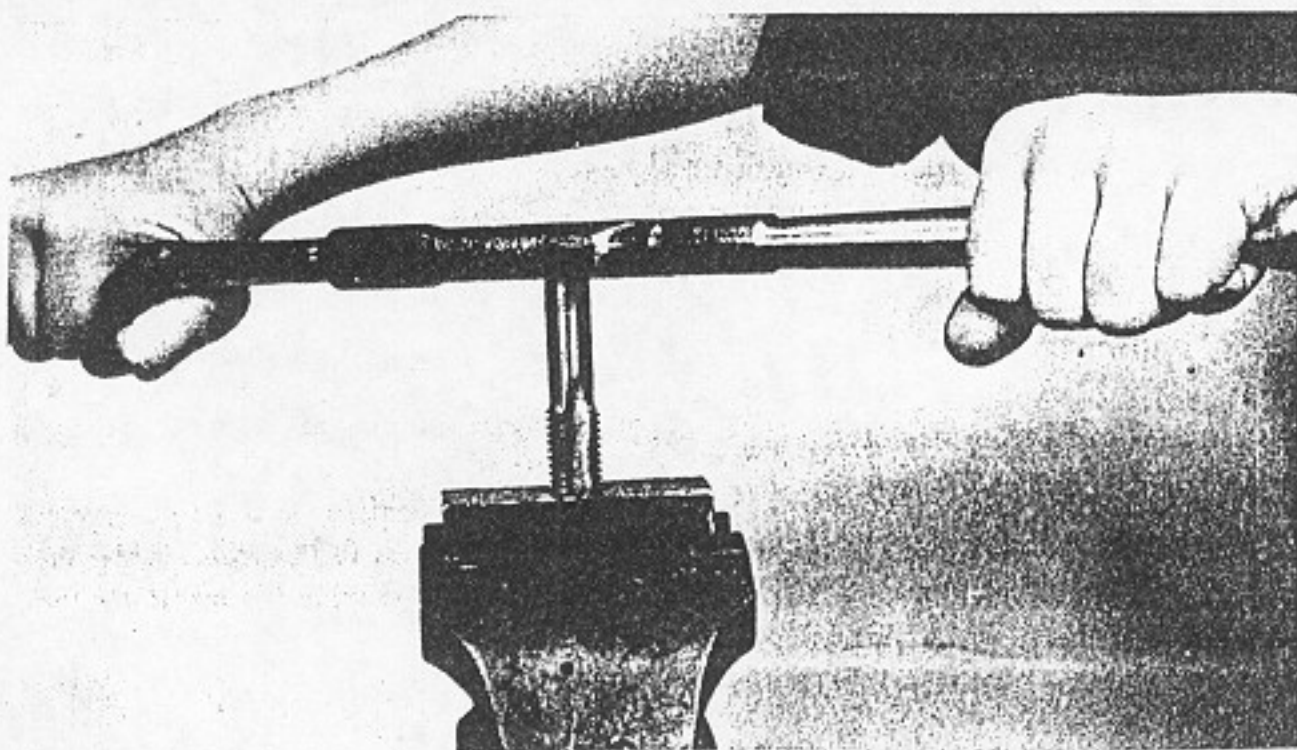


Fig. 5-6. A tap is hard and brittle; for this reason, it is liable to break easily. You should use great care when you are turning the wrench, so as not to break the tap. Above: starting a tap in a drilled hole. Right: checking a tap for squareness after it has been started.

thread desired by turning the adjusting screws of the die stock.

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Die Stock

A die stock is a kind of wrench for holding the die while it is being turned to cut threads on a bolt or rod. There are two types of die stocks (see Fig. 5-7). The one shown in Fig. 5-7a holds the round adjustable die, and the one shown in Fig. 5-7b holds the two-piece die.



(a) Die stock for round adjustable die.



(b) Die stock for adjustable die.

Fig. 5-7. Die Stocks. (Courtesy Greenfield Tap & Die Corp.)

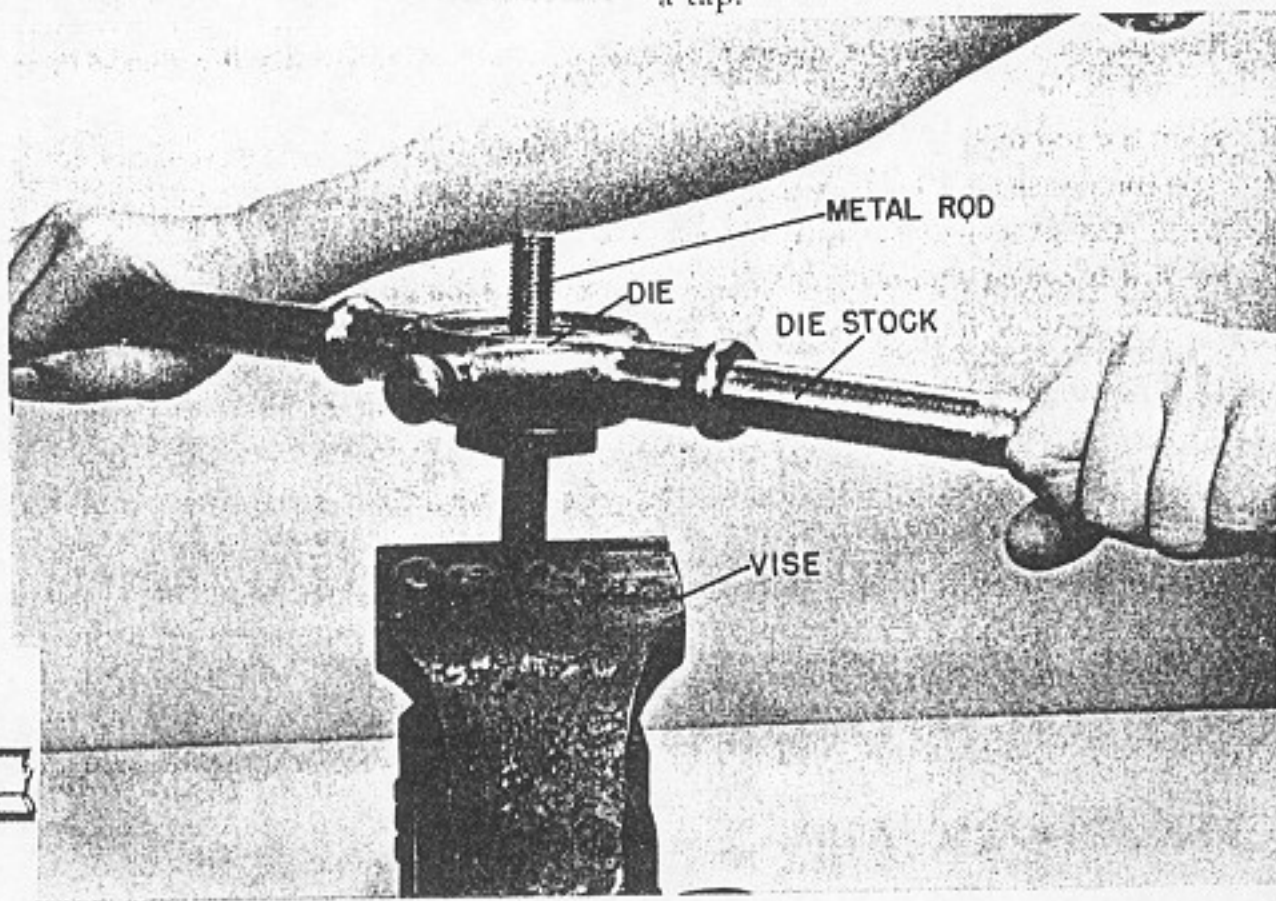
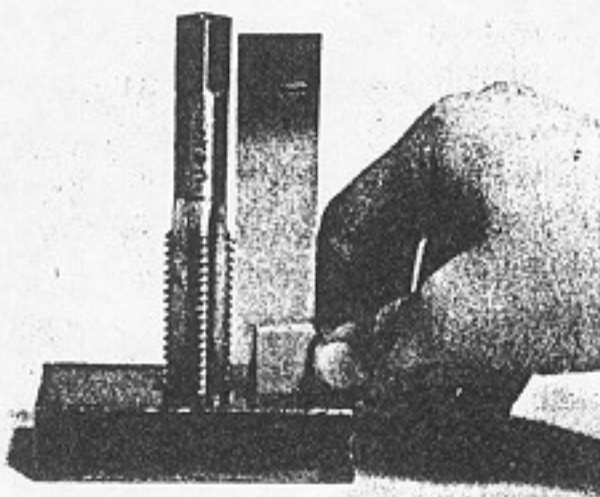


Fig. 5-8. Cutting Threads With a Die. After a thread has been cut, it should be tested by being screwed into the internal thread with which it is to be used. If it fits too tightly, adjust the die to cut a smaller thread. It is always best to cut a thread that is too large. Then adjust the die for a light finishing cut of the thread for a perfect fit.

Using a Die To Cut Threads on a Rod or Bolt. To cut threads on a rod or bolt, a die (see Fig. 5-8) must first be selected. This die must be the same size as the outside diameter of the metal. It is sometimes difficult to start the cut. To overcome this problem, grind or file a slight taper or chamfer (see Fig. 5-9) on the end of the rod. Now, place the die on the end of the rod and slowly turn the die stock two or three turns while bearing down on the handles. After cutting about two turns, sight from two directions along the handles of the die stock to see if it is cutting square with the rod or bolt. If it has not been started square, back the die up a few turns and apply a side-wise pressure to correct the position; then again start turning the die onto the rod. Again check to see if it has been started square. Once it is cutting square, it should be turned from one-half to three-quarters of a turn and then backed up one-half turn. Continue the forward and backward turning until the thread is cut. Cutting oil or a mixture of white lead and oil should be used with a die, just as with a tap.

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Fig. 5-9. Chamfered End of a Rod.

Questions

1. How do we determine the number of threads to the inch on a bolt?
2. What is a tap drill?
3. How can we tell the size of a tap or die?
4. What method is used to test a tap to see if it is cutting square?
5. In what way is it possible to cut a slightly larger or smaller thread than the size stamped on the die?
6. What does NC or NF stamped on a tap or die mean?
7. What advantages are claimed for the round adjustable die over the two-piece die?

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C H A P T E R

6

Tooling, Forming, and Raising Sheet Metal

This chapter covers the following subjects:

Tooling Metal Foil, 49 • Raising Sheet Metal, 51 • Planishing, 54 • Forming Rolls, 56 • Stakes for Sheet Metal Work, 56

To most of us, "sheet metal" means galvanized iron, which is the metal used to make furnaces, garbage cans, and eave troughs. There are, however, many other kinds of sheet metal. It should be thought of as any metal that is made in sheet form, such as aluminum, copper, brass, pewter, galvanized iron, tin plate, and many others. These many kinds of sheet metal provide an opportunity for making a great many interesting and useful articles.

Tooling Metal Foil

The tooling of metal is the art of raising figures or designs on very thin metal by rubbing or pressing on the reverse side of the metal with modeling

tools (see Fig. 6-1). The metal called foil is obtainable in rolls, each 6, 8, or 12 inches wide. As in the case of other sheet metals, the thickness is identified by a gage number. As the gage number becomes larger, the metal becomes thinner. One of the most commonly used is number 36 gage, which is five one-thousandths (.005) of an inch thick. To give yourself an idea of the thinness of 36 gage metal, examine the paper on which this book is printed. It is only about five one-thousandths of an inch thick. Therefore, the metal you would be working on is very, very thin.

Table 3 will give you an idea of the thickness and weights of the different gages.

Tooling the Metal. The tools

used for metal tooling are made in different shapes (see Fig. 6-1). Each has a definite use. They may be made of either wood or metal.

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TABLE 3

GAGE NUMBER AND THICKNESS OF METAL FOIL

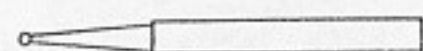
Gage	Thickness	Weight per Sq. Ft.	Sq. Ft. per Pound
36	.005	.2312	4.32
34	.006	.2914	3.43
32	.008	.3677	2.72
30	.010	.4625	2.16

The selection of a design is important. A design that has strong, definite outlines will be more satisfactory for the beginner. You will need a firm, level table top on which to work and a pad of cardboard or several layers of newspaper that will be placed beneath the metal foil upon which the tooling is to be done. Place the foil on the pad and then lay the design on top of it. After doing this, fasten both the design and the foil to the pad with tape before transferring the design onto the foil with the tracing tool by pressing just hard enough to make a clear, fine line in the metal foil. Following this, remove the design from the metal and retrace all lines to deepen them. Remember that the side you have been working on is the top side of the metal. Now turn the metal over on the pad and with a modeling tool retrace the design on the *inside* edge of the original outline. This gives a very definite ridge. Next, place the metal, top up, on a smooth, hard surface, such as a piece of glass, and use the hook end of the modeling tool to tool or work around the outside edge of the design. This forces the background at the edge of the design to lie flat against the smooth surface and also makes the design stand out. Then, turn the metal over so that the top side is down and is resting on the pad.

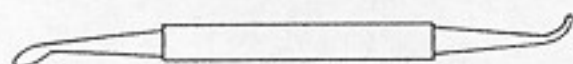
You are now ready to work the design by tooling the metal. Using the spoon end of the tool, spoon out with a downward pressure all the flat surfaces between the lines from the back

side of the metal. Do not force the metal with too much pressure, but

METAL TOOLS



TRACING TOOL

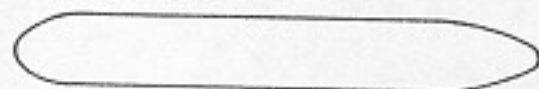


MODELING TOOL

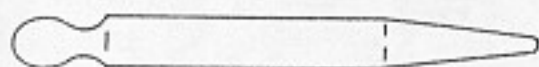


DOUBLE-END BALL MODELER

WOODEN TOOLS



SMOOTHER OR FOLDER



ROUND DETAIL TOOL



MODELER AND SMOOTHER



MODELER

6-1. Modeling Tools.

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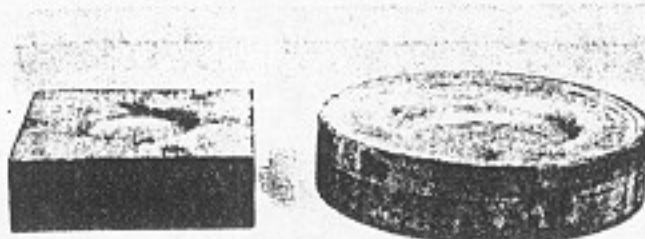


Fig. 6-2. Wood Bowl, Tray, or Plate Forming Blocks.

work carefully over the entire design.

Remember that you are working from the back side. Turn the metal over and examine the front often, for the design is achieved by raising some areas higher than others and not by pressing in some areas from the front side of the metal. Now, raise the different areas higher to bring out the design, using various tools: the spoon for large areas, the smaller ball end for smaller areas, and the pointed tools for small spaces, such as hair, flower stems,

legs of animals, and veins in leaves. Continue this process until the entire design has been raised. Then, turn the metal over and place it on a hard, smooth surface. With the flat end of the tool, smooth out the entire background by working with strokes that move from the edge of the design toward the outside edge of the metal.

Since the metal is very thin, the raised design, if higher than an eighth of an inch, needs some support. This is supplied by filling the depression with plaster of Paris. After this has hardened, rub the front surface lightly with #000 steel wool until it is free from discoloration, grease spots, or fingerprints. After the surface has been polished, it may be colored with chemicals or painted with colored or clear lacquer (see "Metal Finishing"). Metal tooled or embossed pictures may be framed or used to decorate book ends, box tops, or lamp bases.

Raising Sheet Metal

Certain kinds of sheet metal, such as copper, brass, aluminum, pewter, and the soft ductile steels, can be hammered into attractive bowls or trays by a process called raising. One of the easiest ways to form metal by raising is to hammer it on wooden blocks having depressions in them to aid with the forming.

Wooden Forms. The wooden bowl, tray, or plate forms (see Fig. 6-2) provide a simple, easy method of forming metal. Bowls, trays, and plates can be made to conform to the depression in a wooden or metal block. The depth, size, and shape of beaten-down objects are the same as the depressions into which the metal is hammered.

Using Wooden Forms. To use a wooden form for the beating down of metal, first lay out and cut the metal to the size needed. Center it over the depression and hold or clamp it in place. When forming a plate or tray with a flat bottom, strike a series of blows around the outside edge of the

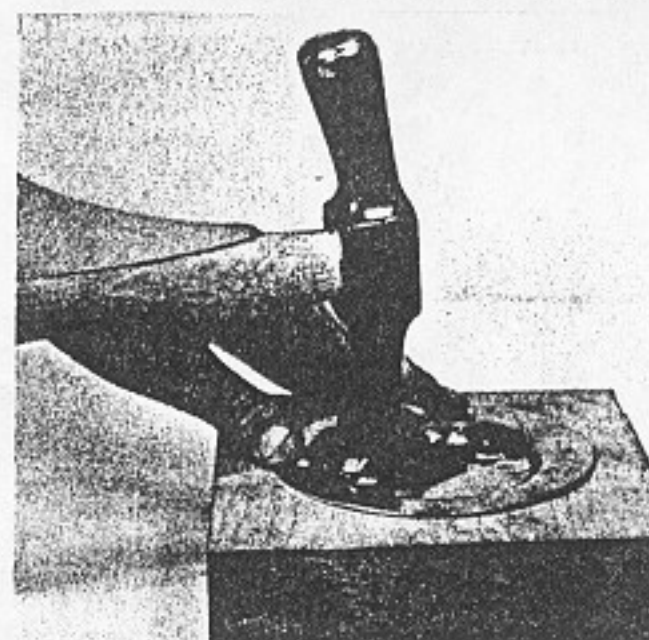


Fig. 6-3. The wooden forming block can be used when several pieces of the same shape and size are to be made.

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depression (see Fig. 6-3) with a raising hammer, mallet, or peen end of a ball peen hammer until the metal touches the bottom of the form. If a bowl is being made, the hammer blows may be started at the center of the disc and gradually worked in a circular pattern to the outside edge of the form. If wrinkles or waves appear at the edge of the metal, they should be flattened out. To do this, it is necessary to remove the

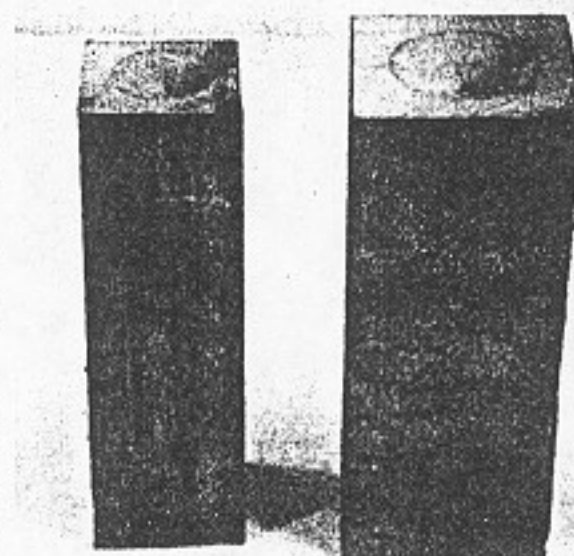


Fig. 6-4. Wooden Forming and Starting Blocks.

metal from the form. Hold the wrinkled edge on a smooth surface, such as a bench top or a stake. Then, use a soft-faced hammer or a wooden mallet to smooth out the wrinkles.

Annealing Copper, Brass, and Aluminum. Copper, brass, and alu-

minum become hard as they are being worked. This is known as "work hardening." To make them soft again is known as annealing. Annealing is accomplished by heating brass to a dull red color, copper to an iridescent red color, and aluminum until chalk marks made on it with mason's chalk turn brown. As soon as the metal becomes hot enough to produce the results mentioned, it is plunged into clear, cold water. This rapid cooling anneals or softens the nonferrous metals, such as copper, brass, and aluminum; however, this process would not anneal ferrous metals, such as steel and iron. The annealing of hardened steel is discussed in Chapter 11.

Wooden Forming and Starting Blocks. To raise metal, wooden forming and starting blocks (see Fig. 6-4) are used. Raising is the process of forming a hollow-shaped object, such as a bowl, from a flat disc by stretching the metal with blows of a hammer. A depression in the end of a hard wood block provides the simplest method of raising metal.

Using Wooden Starting Blocks for the Raising of Metal. Unlike the plate and tray forms, which control the shape of the finished article, the starting block only helps to form the metal during the process of raising. For this rea-

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son, when one wishes to raise metal to a desired shape or to make a number of identical pieces, one should make a template (see Fig. 6-5a), with which it is possible to check the work as it is being raised.

Once the metal has been cut to size, hold it on the starting block so that it covers the depression in the block, with the edge of the disc even with the edge of the depression closest to you. With a silversmith's or ball peen hammer (see Fig. 6-5b) strike the metal just inside

the edge of the depression. This forces the metal to stretch or form itself down and into the depression. Turn the metal with a circular motion, while at the same time striking a series of blows

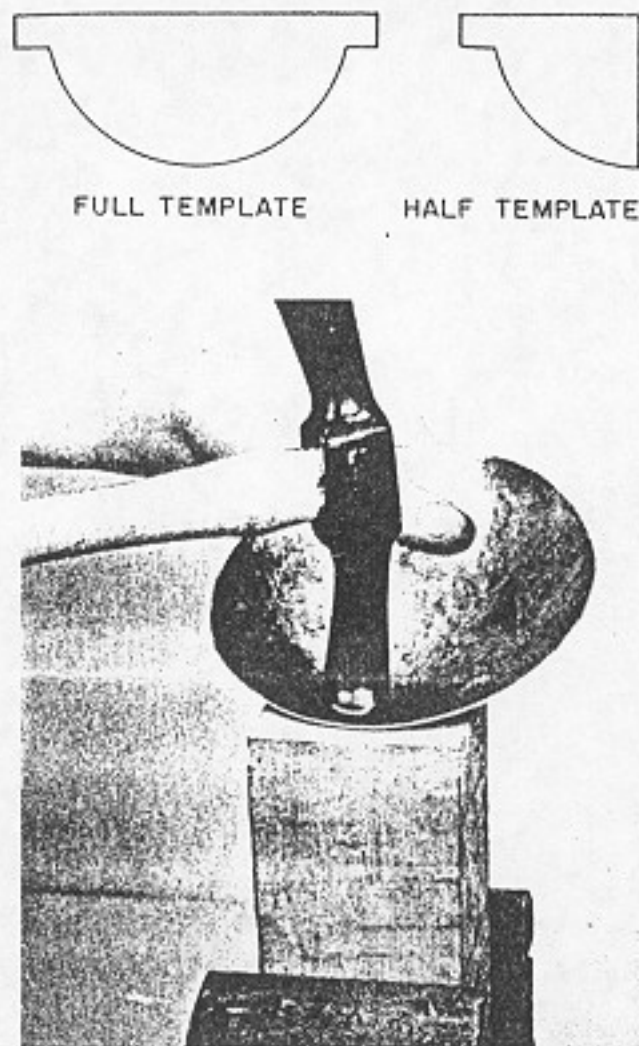


Fig. 6-5. The wooden forming and starting block may be used to raise either deep or shallow articles from large or small diameter discs of metal.

around the entire edge of the disc. Move the metal so that a new series of blows may be struck. Repeat this procedure until the circular rows of hammer marks reach the center of the disc. Then test the raised metal with the template. Continue to raise the metal

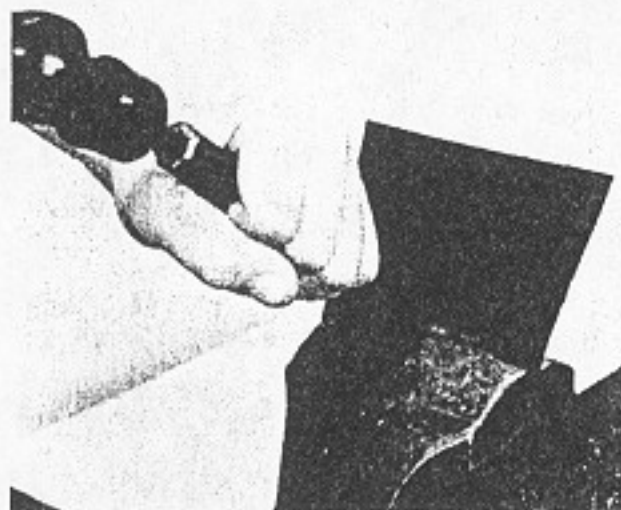


Fig. 6-6. Have the line on the metal even with the top of the vise jaw. Force the metal to rise a little at a time, by moving the tool along the vise jaw after each hammer blow.

until it fits the template. As the metal takes shape, it must be tilted up at the back (see Fig. 6-5b) so that the hammer blows will always be struck directly over or at the edge of the depression.

Hammering copper, brass, and aluminum hardens the metal, which should be annealed as often as necessary. (See the discussion of this process on page 52.)

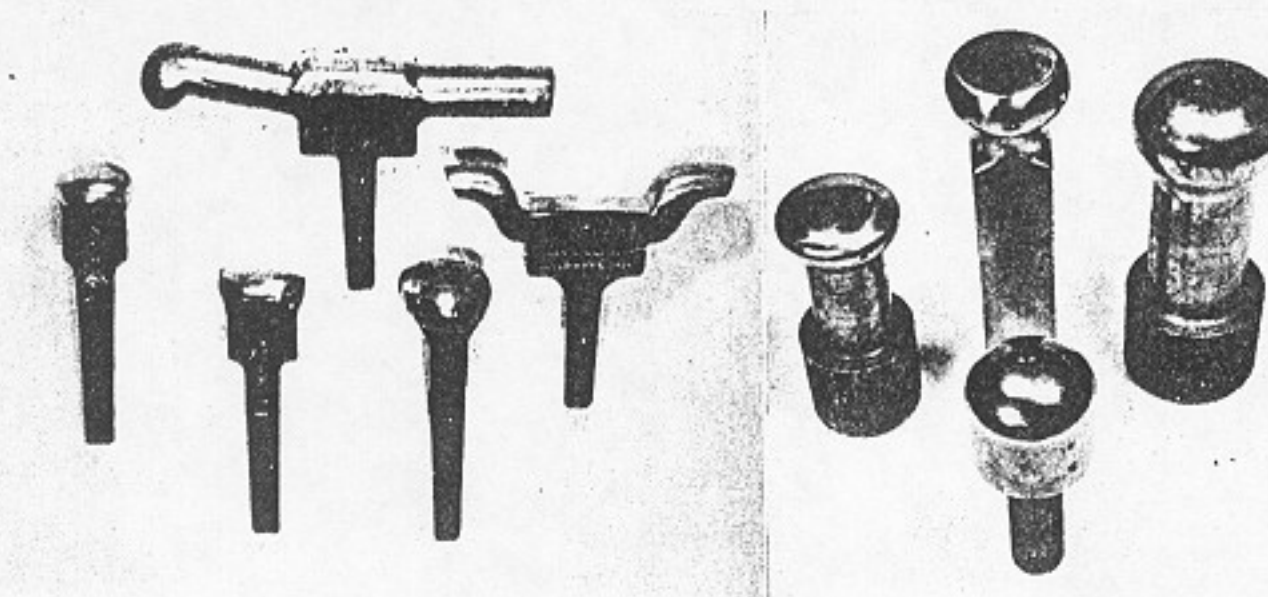
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Raising at a Vise. Ferrous metals, such as sheet steel, are more difficult to raise because they are harder, tougher, and stiffer than the nonferrous metals. Although ferrous metals may be raised in the same manner as copper or brass, to do so often spoils the wooden form or starting block. For this reason, it is generally best to raise this type of metal along a straight line, as in a diamond or a rectangular shape. When designs of this nature are used, the jaws of a vise and a piece of metal can be used to do the raising, as illustrated in Fig. 6-6.

Planishing

Planishing consists of making a metal surface smooth by pounding it gently with a smooth-faced hammer while the metal is held on a solid surface, such as a stake. When this is done, the bumpy, uneven surface that was created by blows of the hammer during the process of raising may be eliminated.

The shape of the stake used when planishing should conform as closely as possible to the shape of the article being planished (see Fig. 6-7a). Place the stake in a stake plate (see Fig. 6-7c) or hold it in a vise. With one hand, hold the metal on the face of the stake while at the same time striking the outer surface with a planishing hammer (see Fig. 6-8a). Move the metal after each hammer blow. The hammer must strike the metal squarely. If it is tilted, the edge of the hammer will leave marks in the metal. Planish the entire surface with hammer blows that overlap one another, making a



(a)

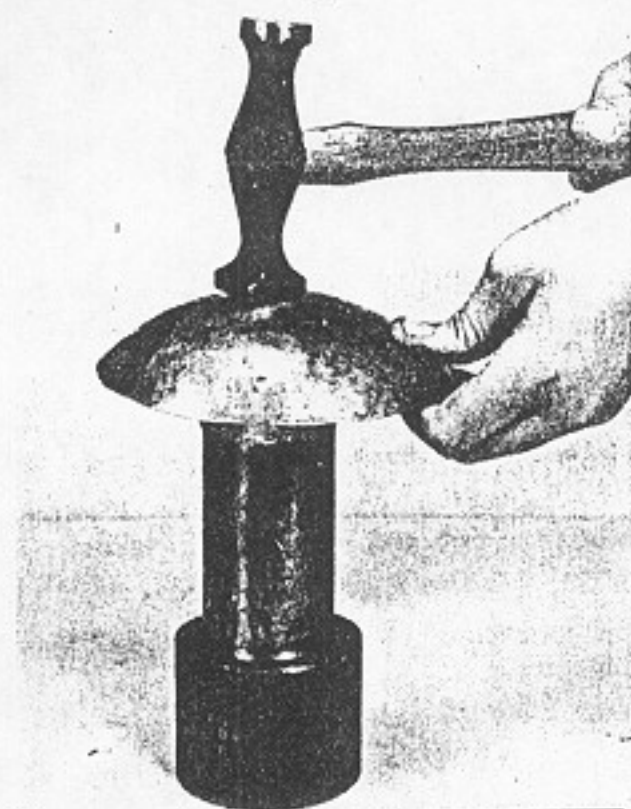
(b)



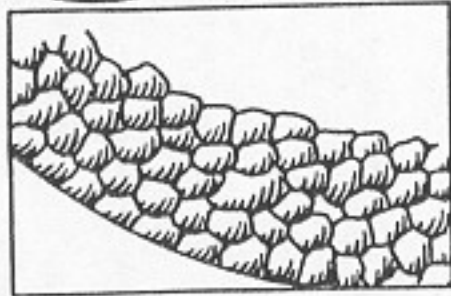
(c) (Courtesy Peck, Stow and Wilcox Co.)

Fig. 6-7. Metal craft stakes (a and b) are made in a wide variety of shapes and sizes, with the working surface highly polished. They can be held in a stake plate (c) or a vise.

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(a)



(b)

Fig. 6-8. The faces of planishing stakes and hammers should be polished to a glasslike finish. As shown in (b), the planishing marks should touch each other.

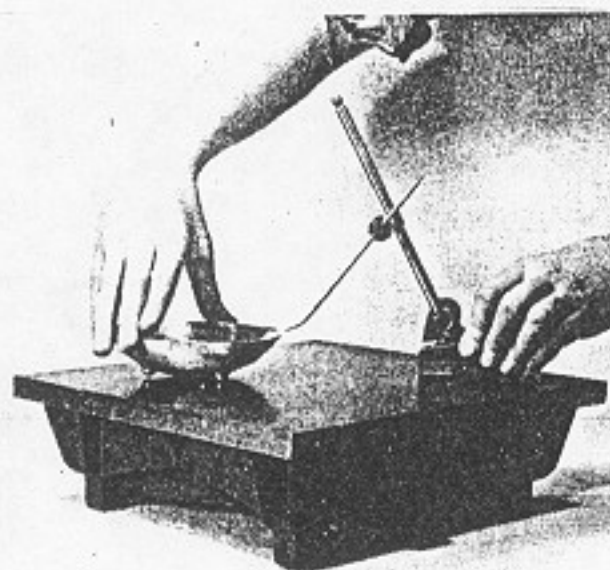


Fig. 6-9. If considerable metal is to be removed, it may be cut off with tin snips. However, filing will generally true up the top edge.

smooth surface that is easily polished (see Fig. 6-8b). Planishing also stiffens the metal.

As a result of planishing and raising, the top edges of bowls and other articles that have been raised by hand are usually uneven. To indicate the unevenness of the top edge of a raised bowl, a surface gage is used. The first step is to set the base of the bowl on a

smooth, flat surface. The bowl is then turned while the scribe point of the surface gage is adjusted to the lowest place on the top edge of the bowl. Hold the surface gage stationary and revolve the bowl or hold the bowl and move the surface gage, scribing a line parallel to the surface that the bowl is resting on and around the top edge of the bowl (see Fig. 6-9). True up the top edge by working the uneven metal down to the line with a suitable tool.

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Forming Rolls

Forming rolls (see Fig. 6-10) are used to form sheet metal cylinders from flat sheets and wire into circles. The forming roll is turned by a crank handle attached to the right-hand end of the machine.

Using Forming Rolls to Form Sheet Metal. To form a piece of sheet metal into a cylinder, raise the top roll of the forming rolls and place one edge of the metal a little past the center of the bottom roll. Lower the upper roll onto the metal and adjust the back roll so that the metal will touch this roll as it is being rolled through the machine. Roll the metal through the machine several times (see Fig. 6-11) while raising the back roll. This procedure will gradually form the metal into a cylinder.

Forming Wire with the Forming Rolls. The groove at one end of the rolls of a forming roll are placed there for the forming of wire into circles or hoops (see Fig. 6-12). The same procedure is used to form a wire circle as is used to form a sheet metal cylinder with the forming rolls.

Stakes for Sheet Metal Work

Sheet metal is shaped and formed over stakes (see Fig. 6-13). This forming is done by working or rolling the metal over the surface of a stake by hand or by using hand tools.

Using a Stake to Form Square Sheet Metal Brakes by Hand. Quite often when you're making something

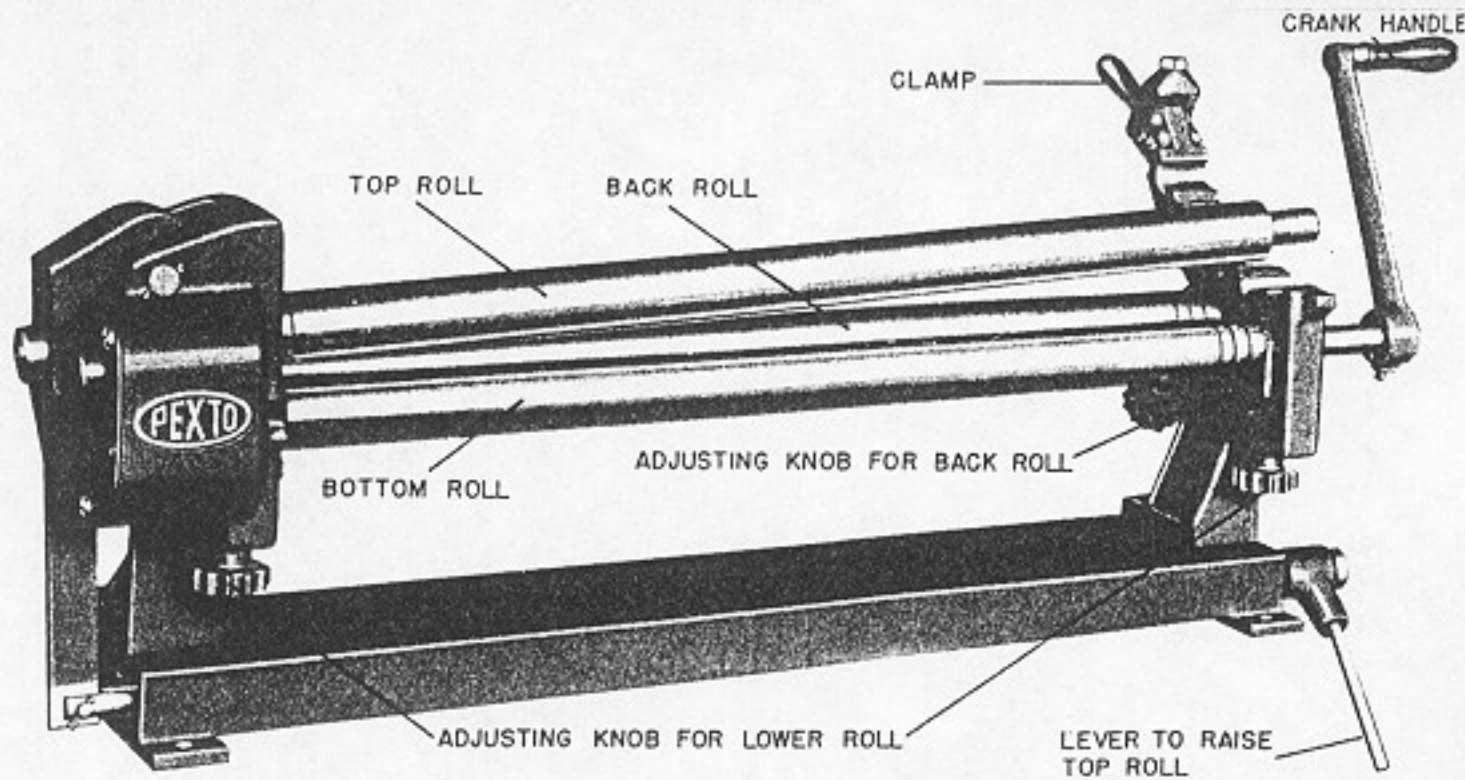


Fig. 6-10. Forming Rolls. (Courtesy Peck, Stow and Wilcox Co.)

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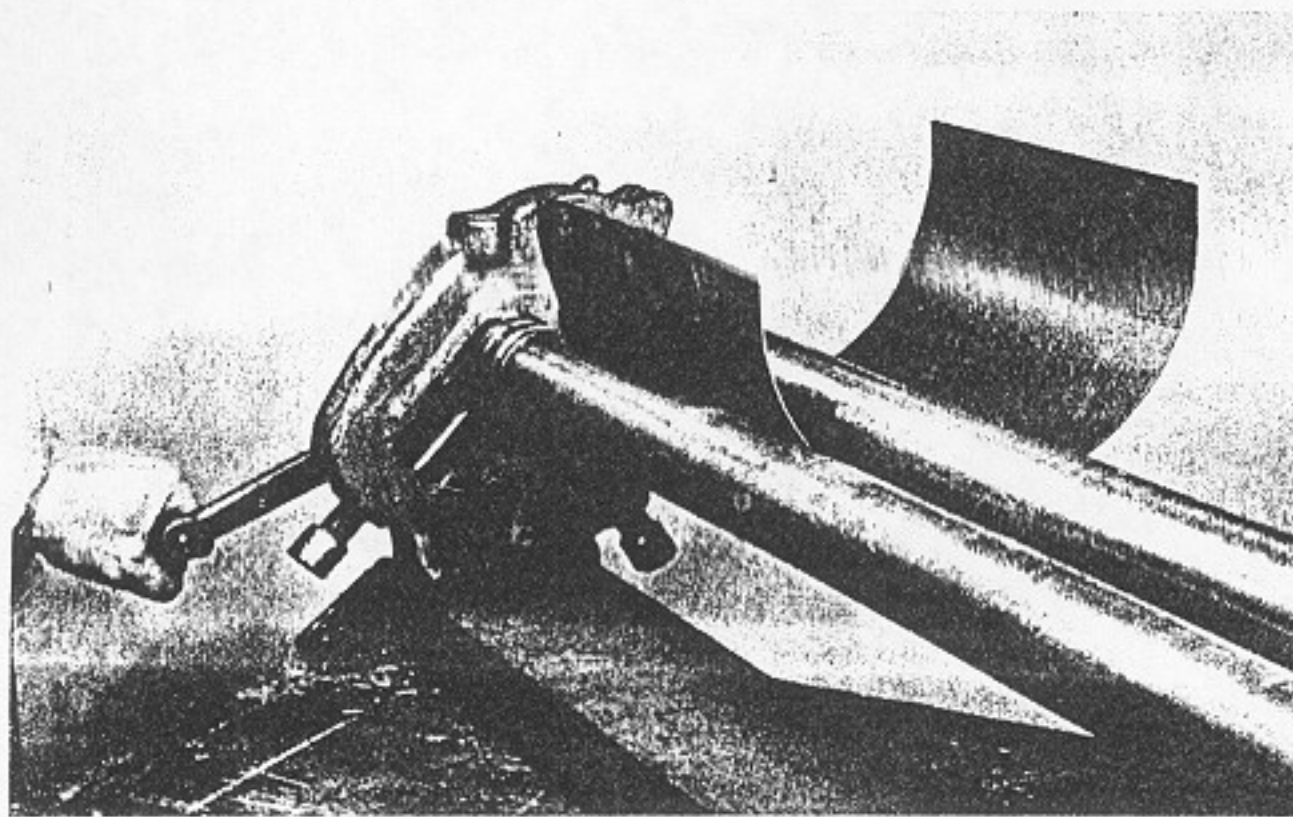


Fig. 6-11. It is necessary for the back roll to be kept parallel to the top and bottom rolls.

out of sheet metal, it is necessary to make a sharp bend in the metal. To the sheet metal worker, this is known as braking the metal. To make these brakes by hand, bend the metal over a straight edge of a bench or stake. To brake the metal, hold the location for the brake directly over the edge of a stake (see Fig. 6-14). With a mallet, or by hand, gradually bend the metal down; the sharp brake at the edge of the stake is the result of blows being struck with a mallet on both the top and side of the stake.

Using a Stake to Form Sheet Metal Cylinders by Hand. Cylinders, such as stovepipes and wastebaskets, that are made from sheet metal can be formed around a stake. The stake should be round. To start forming the metal, hold one edge on the stake as in Fig. 6-15a, and start the bend with a mallet. Do the same with the opposite edge. **CAUTION:** MAKE CERTAIN THAT BOTH STARTING BENDS HAVE BEEN MADE IN THE SAME DIRECTION. To complete the cylinder, hold

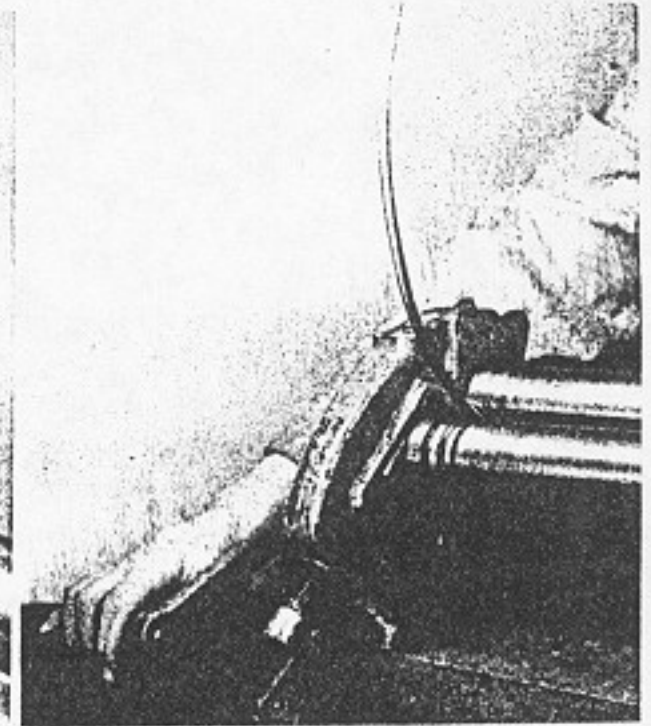


Fig. 6-12. Perfect circles can be formed with wire in the forming rolls, as shown in this picture.

one of the bent edges on the stake and with both hands bend the rest of the metal as far around the stake as possible (see Fig. 6-15b). If you find that this does not completely form the cylinder, you should place the bend on the opposite edge of the metal on the stake and then bend the metal around the stake until a cylinder or pipe has been formed.

If the edges of the metal are to be fastened together by a seam, complete the seam by riveting, grooving, or soldering. Finish forming the metal after the seam has been completed.

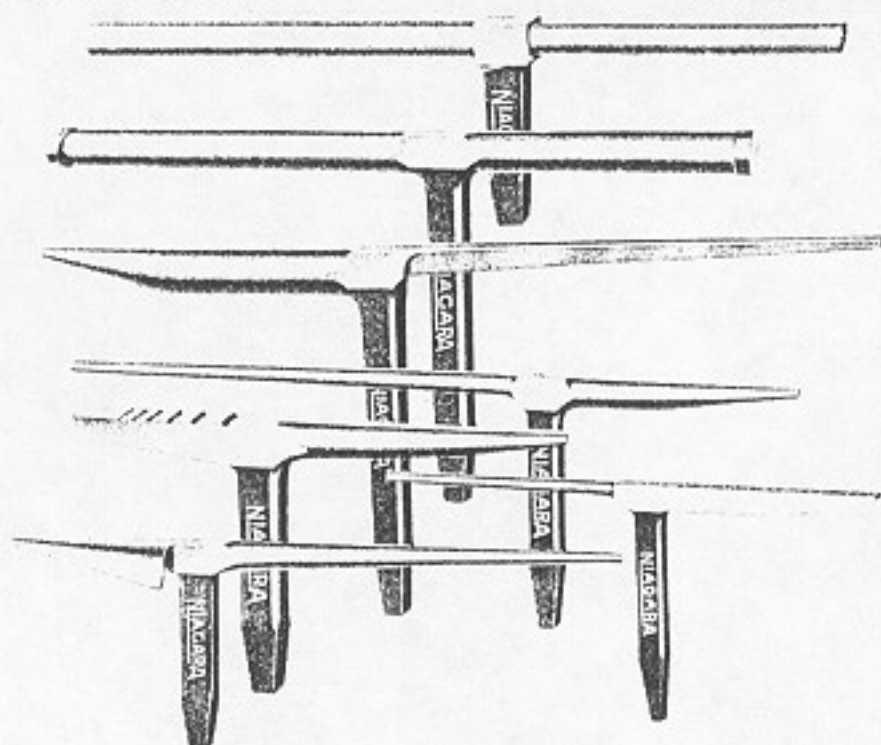


Fig. 6-13. Stakes Used in Sheet Metal Work. (Courtesy Niagara Machine and Tool Works.)

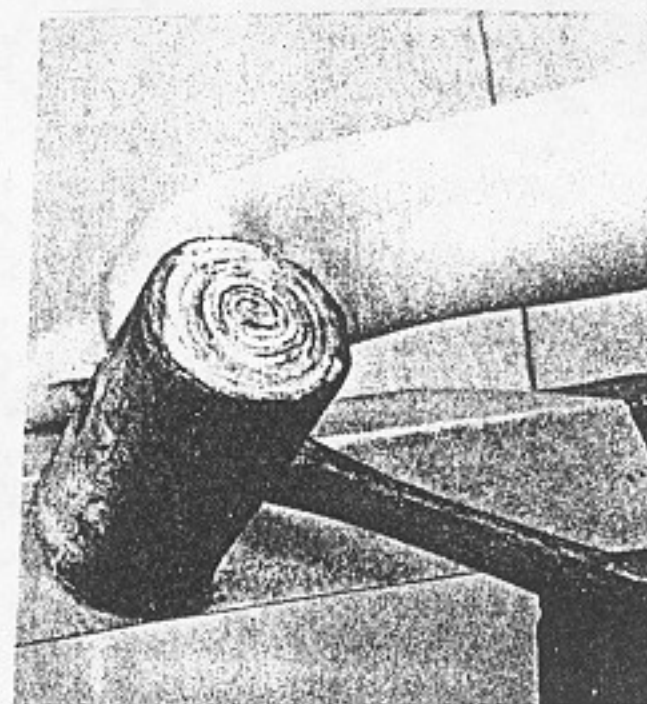
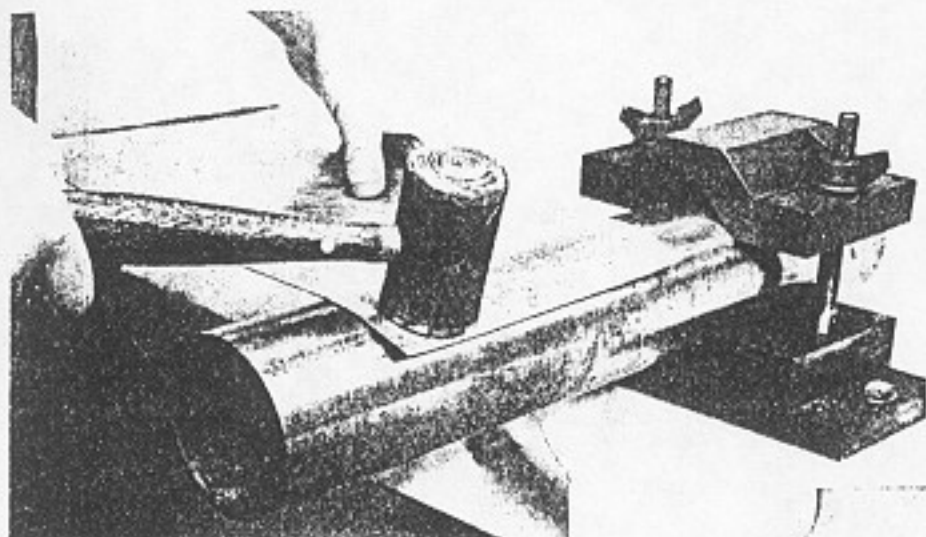


Fig. 6-14. It is often possible to obtain a sharper brake if the metal is struck glancing blows with the mallet rather than blows that are directed straight at the metal.



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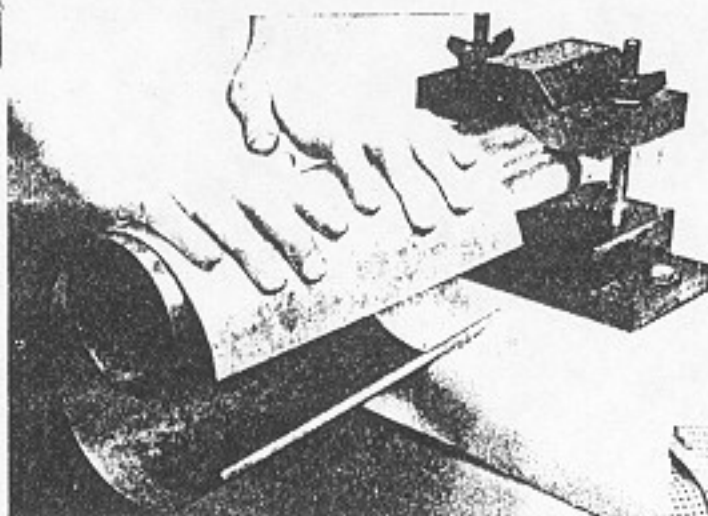


Fig. 6-15. It often helps in the forming of cylinders if the metal is worked with a sliding, rolling motion under the hands across the surface of the stake.

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Using a Stake to Form Conical Sheet Metal Jobs by Hand. To form sheet metal jobs shaped like a funnel, select a stake of the proper shape. Hold one edge of the metal on the stake and with a mallet start the bend (see Fig. 6-16a). Do the same with the opposite edge of the metal. CAUTION: MAKE CERTAIN THAT BOTH STARTING BENDS ARE MADE IN THE SAME DIRECTION. Now place one bent edge

over the stake and grip the metal with both hands (see Fig. 6-16b). Bend the metal around the stake with a sliding, rolling motion of the hands and the metal. Kinks or break lines will be noticeable if the metal is bent too fast. If the edges of the metal are to be fastened together by a seam, complete the seam by riveting, grooving, or soldering. Finish forming after the seam has been completed.

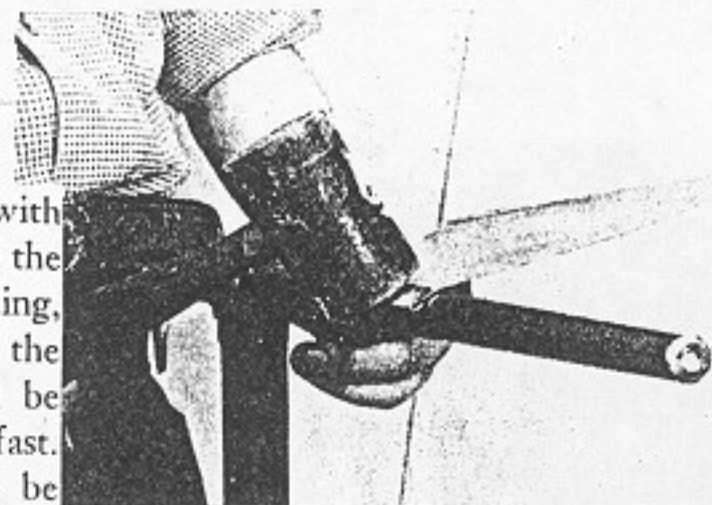
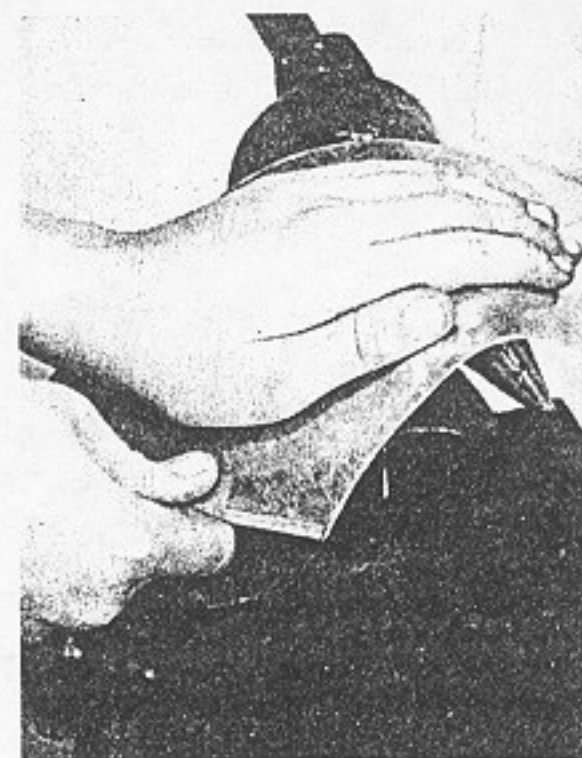


Fig. 6-16. The blowhorn stake is used in the forming of conical shapes from sheet metal.

Questions

1. What are some of the advantages in using forming blocks when beating down metal?
2. In what way does the starting block differ from the forming block?
3. What would determine your using a starting block in place of the forming block?
4. What are the two pieces of equipment used to scribe a line around the top edge of a raised article?
5. List a few of the uses for stakes.
6. Why should metal be formed gradually over a stake?
7. What is planishing?
8. Why is it not necessary to use carbon paper when transferring a design onto metal for metal tooling?

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C H A P T E R

7

Folding and Joining Sheet Metal

This chapter covers the following subjects:

Notches, 61 • Edges Used on Sheet Metal, 61 • Seams Used in Sheet Metal Work, 70 • Soldering, 72 • Rivets—Kinds and Sizes, 78 • Welding—Oxyacetylene and Arc, 80

It is often necessary to fasten metal sheets together when making something with sheet metal. The joint is called a *seam*. When the edge of a piece of sheet metal is folded over to make it stronger, a *hem* is formed.

Quite often when the edges are folded over to make a hem, there will be an overlapping of the metal that causes wrinkles or bulges. This is especially true at corners. To overcome this, it is necessary to remove some of the metal. This process is known as *notching*. The size, shape, and location of the notch depend on how and where the metal is folded.

Notches

A notch is a V-shaped cut as shown in Fig. 7-1a, a square cut (Fig. 7-1b), or a slanted cut (Fig. 7-1c) made in the edge or at the corners of a piece of sheet metal. Notches must be cut to remove metal that would hinder the bending or the folding of the flat sheets of metal.

Edges Used on Sheet Metal

The edge of a sheet metal object is not very strong or rigid, owing to the thinness of the metal. If greater strength is desired, reinforce the edges by folding the metal to provide additional thickness or by fastening wire or metal to the edge. When a sheet metal edge is not folded, it is sharp. This sharpness should be removed with a file or abrasive cloth. The three most common sheet metal edges are the single hem, the double hem, and the wired edge (see Fig. 7-2).

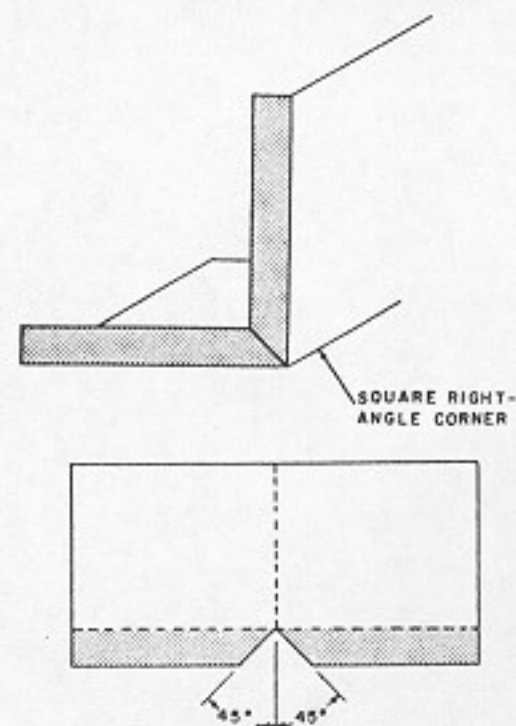
Hems Made by the Hand Method. *Single and Double Hems.* As was previously stated, a hem is used to stiffen an edge and to make an edge that is not sharp. This is accomplished

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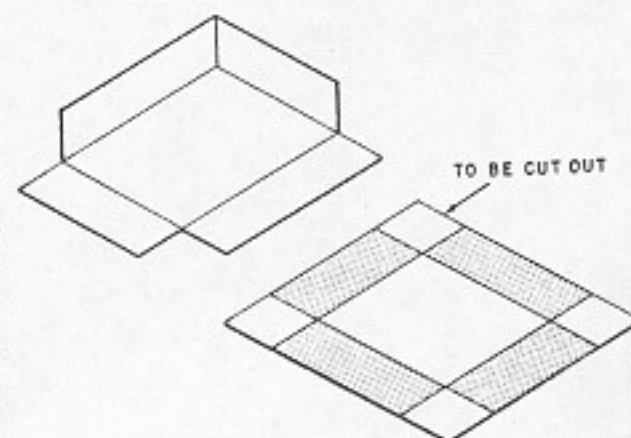
by folding the edge over once for a single hem (see Fig. 7-3f) and twice for a double hem (see Fig. 7-3e). Hems may be made by hand if your shop is not equipped with a bar folder.

Using Hand Tools to Make a Single or Double Hem by Hand. The width

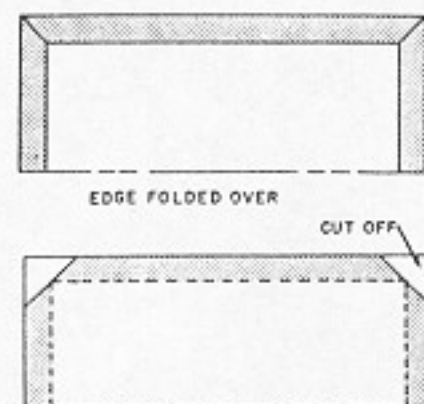
of the hem is carefully marked by drawing a line with a pencil where the fold will be made. A straightedge is



(a) V Notch. Unshaded area is cut out to make possible the bending of sheet metal as shown.



(b) Square Notch. Unshaded area is cut out to make possible the bending of sheet metal as shown.



(c) Slant Notch. Unshaded area is cut out to make possible the folding over of an edge.

Fig. 7-1.

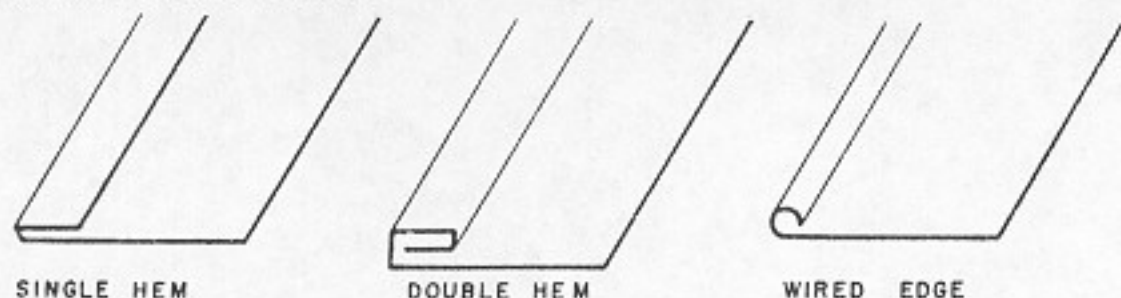


Fig. 7-2. Edges used on sheet metal.

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clamped on the metal, over the edge of a bench (see Fig. 7-3a) or in a vise (see Fig. 7-3b). Use a wood or hard rubber mallet in order not to damage the sheet metal (see Fig. 7-3c). After bending, smooth the bend with a block of wood (see Fig. 7-3d). After the edge has been smoothed, it can be removed from the clamps. Turn the metal over on top of the bench. For a single hem, bend the metal over with a mallet (see Fig. 7-3f); for a double hem, repeat the process a sec-

ond time (see Fig. 7-3e). The second bend should be equal to the width of the single hem.

Hems Made with a Bar Folder. A bar folder (see Fig. 7-4) is a machine used for the bending or folding of sheet metal to an angle or lock. In order for an accurate sharp bend to be made, the sheet metal must be held firmly in the machine making the bend; the bar folder does this automatically during the bending process.

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ess.

Using a Bar Folder to Fold or Hem an Edge. To fold or hem an edge, set the bar folder for the amount of metal to be folded. Insert the edge to be folded in the machine (see Fig. 7-5a). While holding the metal with one hand, raise the handle folding the metal (see Fig. 7-5b). Remove the metal from the machine and then place it on the folding blade (see Fig. 7-5c). Complete the hem by pressing down on it with the wing of the bar folder. If a double hem is to be made, repeat the process. Folds other than those used for a hem are also made with the bar folder (see Fig. 7-5d).

Wired Edges Made by the Hand Method. *Using Hand Tools to Wire a Sheet Metal Edge.* To wire a sheet metal edge, you must figure the amount of sheet metal necessary to wrap

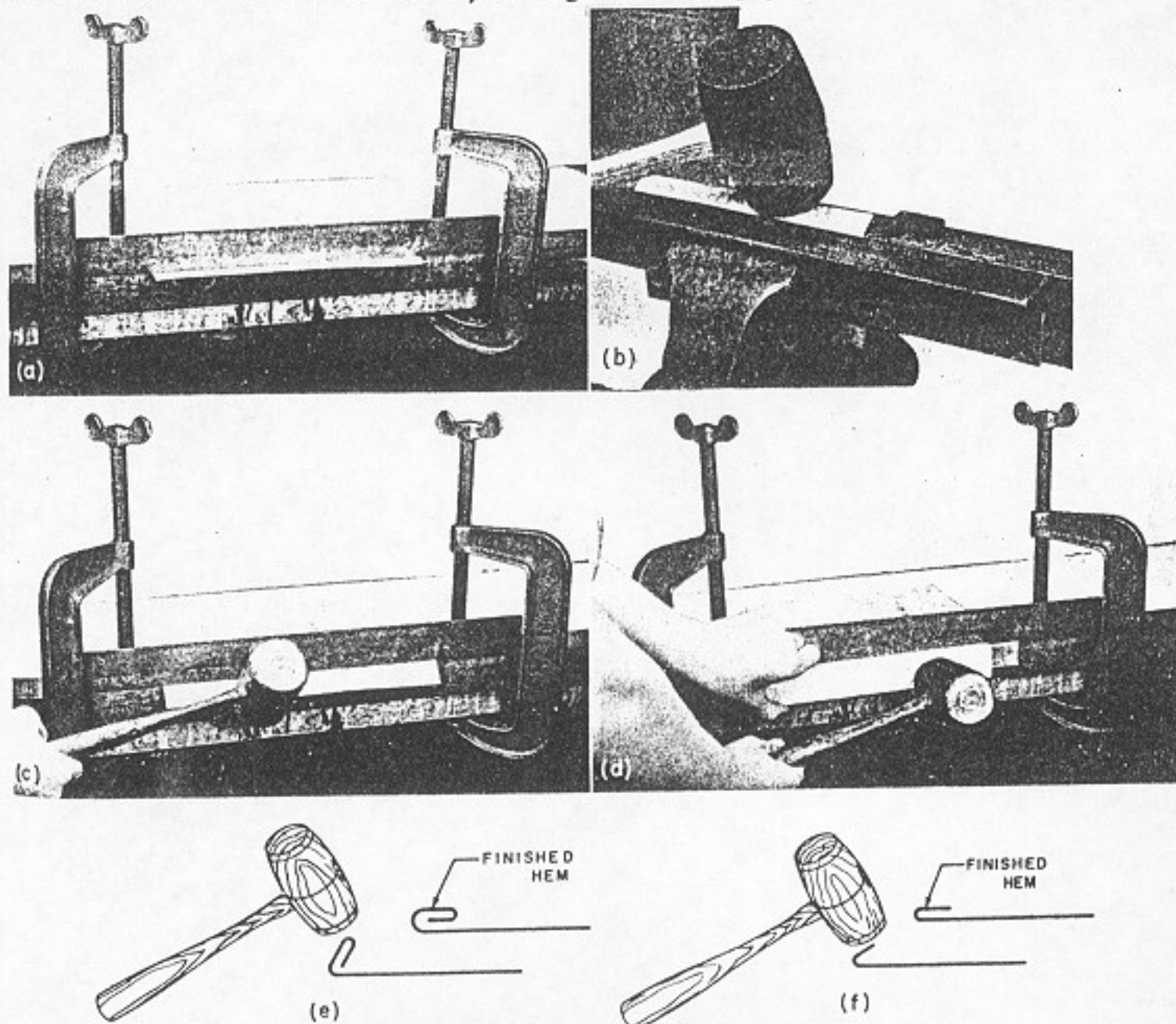


Fig. 7-3. Do not flatten the top edge of the hem with the mallet; it should be left round. This gives the edge additional stiffness.

around a given piece of wire. The amount of metal needed is two and one-half times the diameter of the wire being used. To wire an edge, round off the edge of a block of wood or a bar of metal to the same radius as the wire being used. Place the block of wood or metal right on the edge of the bench and lay the metal on the block. It is best to place a second block on the bench close to the back edge of the metal so that the sheet of metal is held level. Extend the amount of metal that is to be wrapped around the wire out over the edge of the rounded block. Clamp a piece of hard wood or angle iron to the block, with the edge even with the line that indicates the amount of metal allowed for wiring (see Fig. 7-6a). Make certain that the metal has not shifted. Bend the metal down a small amount by striking it with a mallet. Repeat a number of times, making small bends each time until the radius bend over the block has been

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formed. Remove the metal from the clamps and turn it over on top of the bench. Cut the wire to the length necessary for the job being made and straighten the wire. Then bend it to the shape of the object being made. Make certain that the ends of the wire do not meet at a corner or directly over a seam (see Fig. 7-6b). Place the wire in the radius bend. Hold the wire there with a pair of pliers (see Fig. 7-6c) and use a mallet to wrap the metal as far as possible around the wire. Complete wrapping the metal

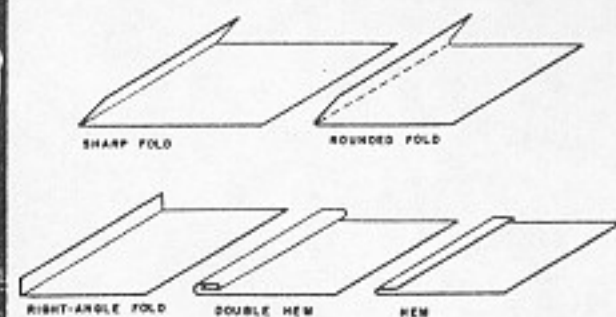
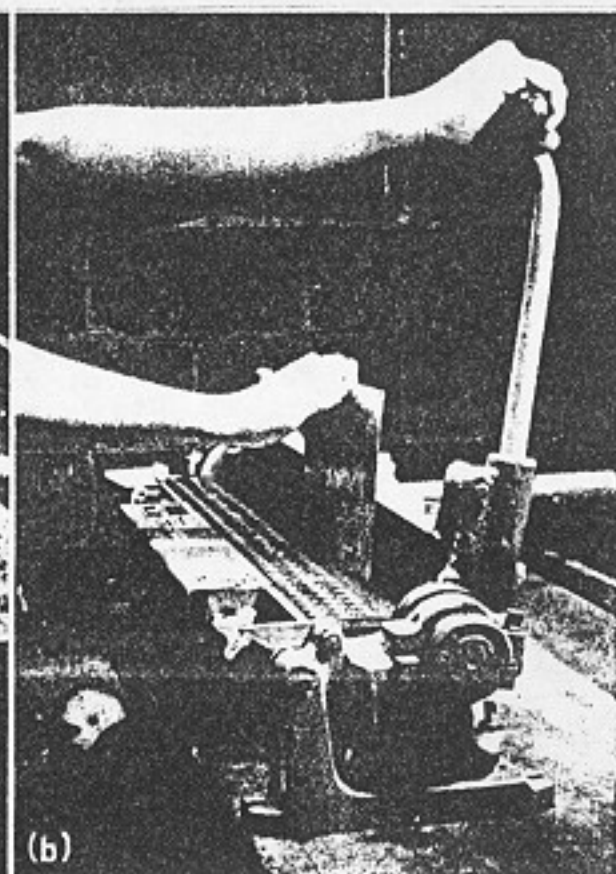
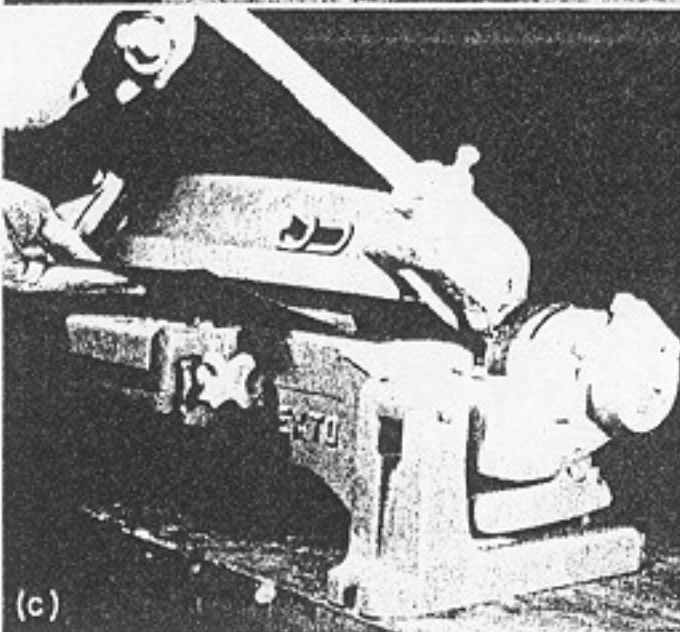
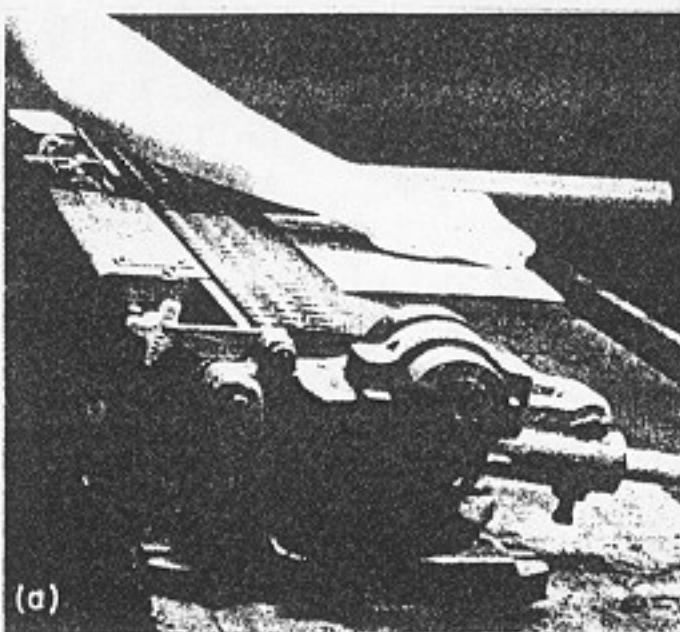


Fig. 7-5. Sheet metal edges from $\frac{1}{8}$ inch in width to 1 inch can be folded with most bar folders.

around the wire with the peen end of a setting hammer (see Fig. 7-6d).

Wired Edges Made with the Bar Folder. *Using a Bar Folder to Fold a Sheet Metal Edge for Wiring.* The wing of the bar folder must be lowered in order to fold an edge for wiring. To do this, place a short piece of wire that is the same size as the wire to be

used on the wing of the bar folder. Now loosen the lock screw (see Fig. 7-4), making possible the lowering of the wing with the wing adjusting lever. Lower the wing until the top of the piece of wire is even with the bottom edge of the folding blade (see Fig. 7-7). Now tighten the lock screw. Adjust the depth gage to one-third the

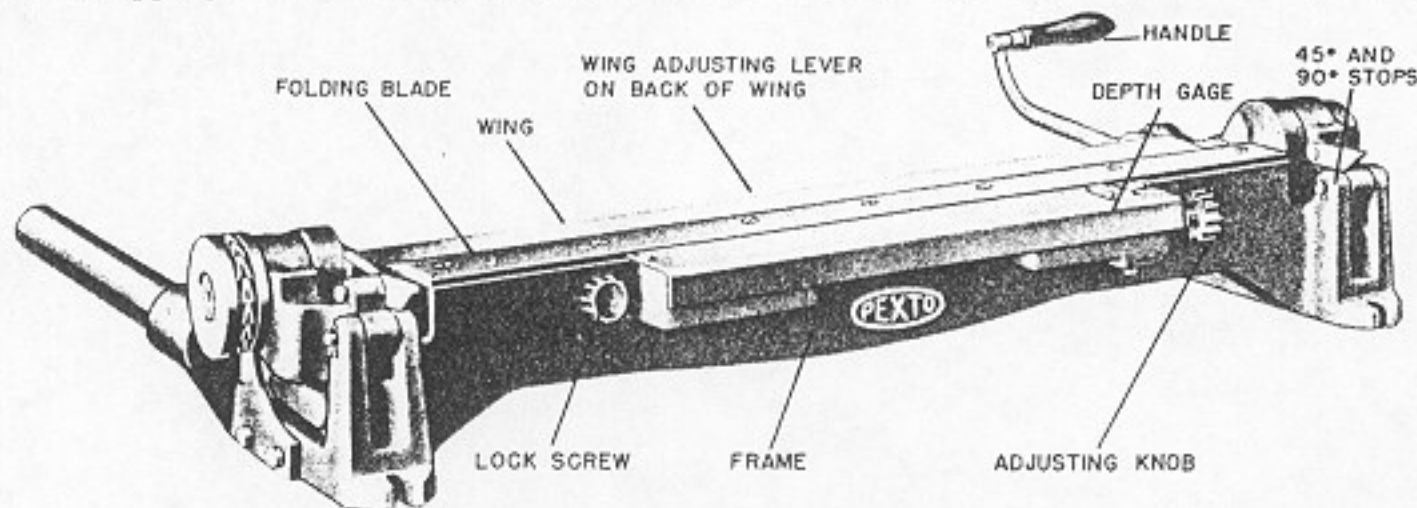
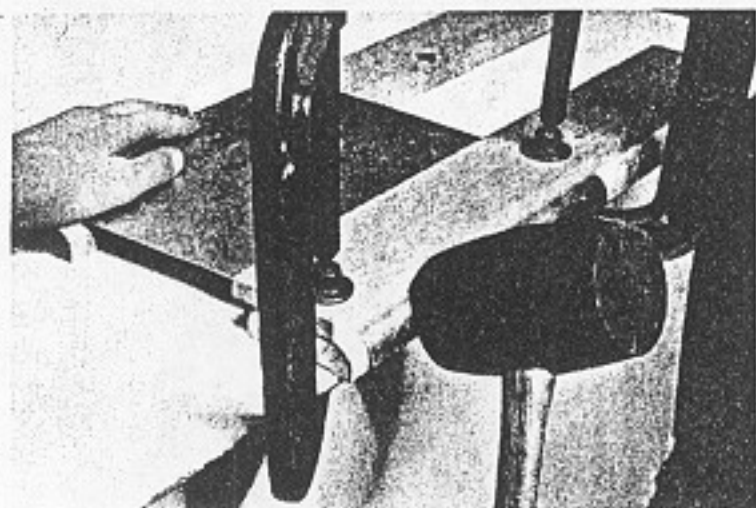
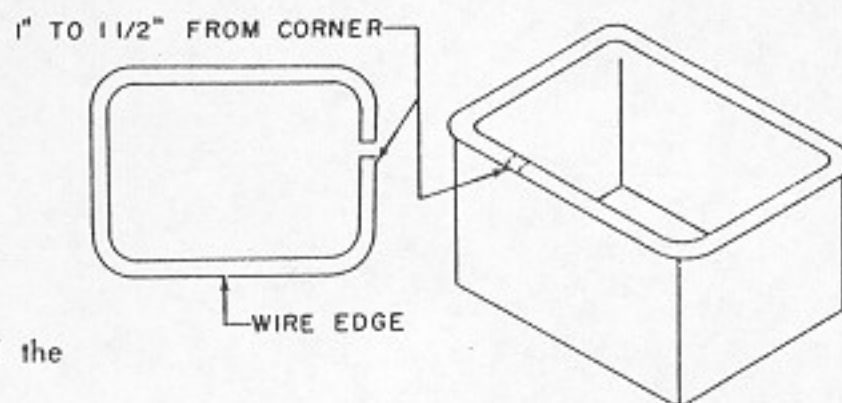


Fig. 7-4. Bar Folder. (Courtesy Peck, Stow and Wilcox Co.)

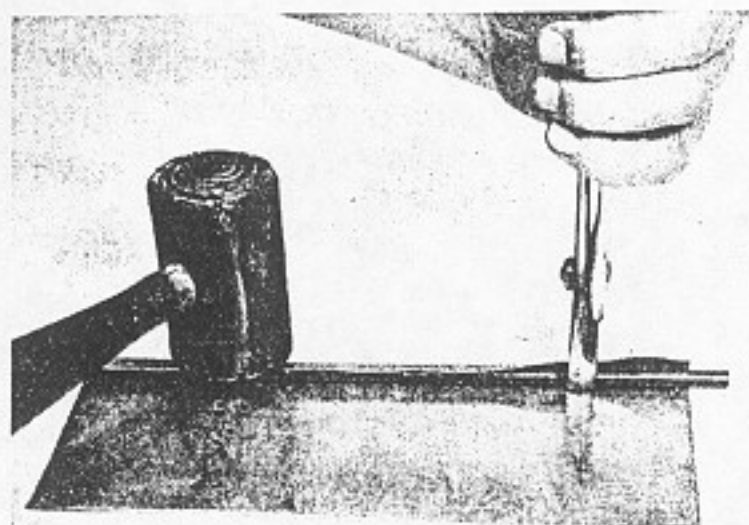


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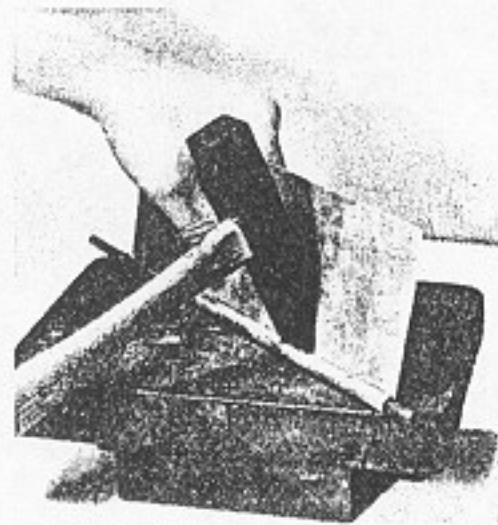
(a) Metal clamped in place and being formed over a radius block with a mallet.



(b) Wire formed to shape of the edge to be wired.



(c) Holding wire in radius bend with pliers while forming the metal around the wire with a mallet.



(d) Using peen end of a setting hammer to complete the wiring of an edge.

Fig. 7-6. The place where the two ends of the wire meet is the weakest spot on a wired edge. For this reason the ends of the wire are never located at a corner or over a seam.

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amount of the metal allowed for wrapping around the wire. This metal allowance is two and one-half times the diameter of the wire being used. Now insert a small practice piece of metal in the bar folder and fold the metal over. To make sure the right amount of metal has been folded, wrap the practice piece around a piece of wire that is the same size as the wire to be used. This can be done by the hand

method (see Fig. 7-6) or by combination rotary machine (see Fig. 7-8). If the setting of the bar folder is not right, set the gage again and practice once more. When the setting is correct, the edge to be wired can be folded. Remember that either straight edges or edges of cylindrical pieces may be wired by hand or by machine.

Edges Made with the Combination Rotary Machine. *Combination*

Rotary Machine for Turning, Wiring, and Burring. A combination rotary bench machine (see Fig. 7-9) will do burring, turning, and wiring on edges of sheet metal. Each of the different edges is made by changing parts known as rolls. Different sets of rolls are used

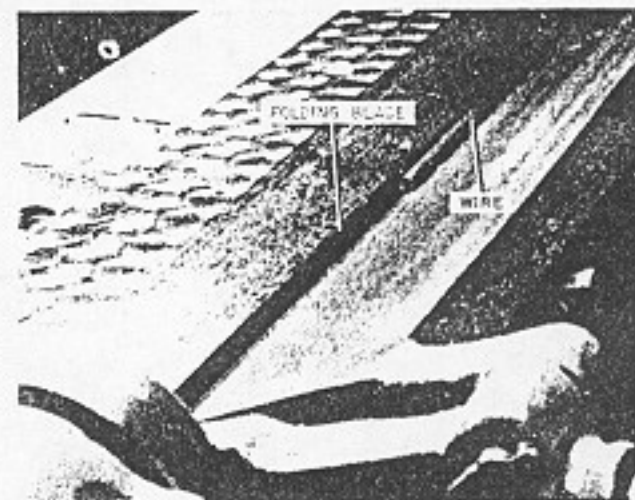


Fig. 7-7. Hold the metal securely in the bar folder until the wing has been raised to grip the metal.

for burring, for turning, and for wiring.

Using a Combination Rotary Machine to Turn a Sheet Metal Edge. First, make certain that the turning rolls are on the machine (see Fig. 7-9b). Then, set the gage on the machine

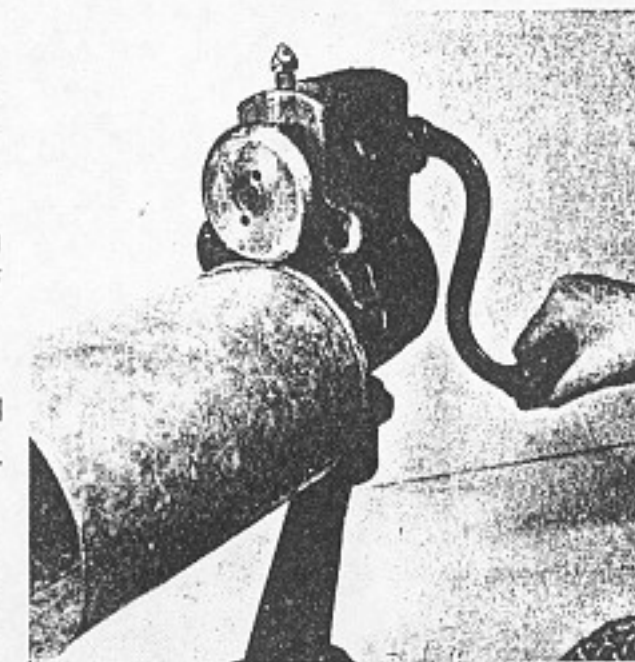


Fig. 7-8. Wiring machines may be used to wire straight edges as well as circular edges.

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to the correct width of the edge being turned. This distance should be measured from the gage to the center of the lower roll (see Fig. 7-10a). Then hold the edge of the metal to be turned

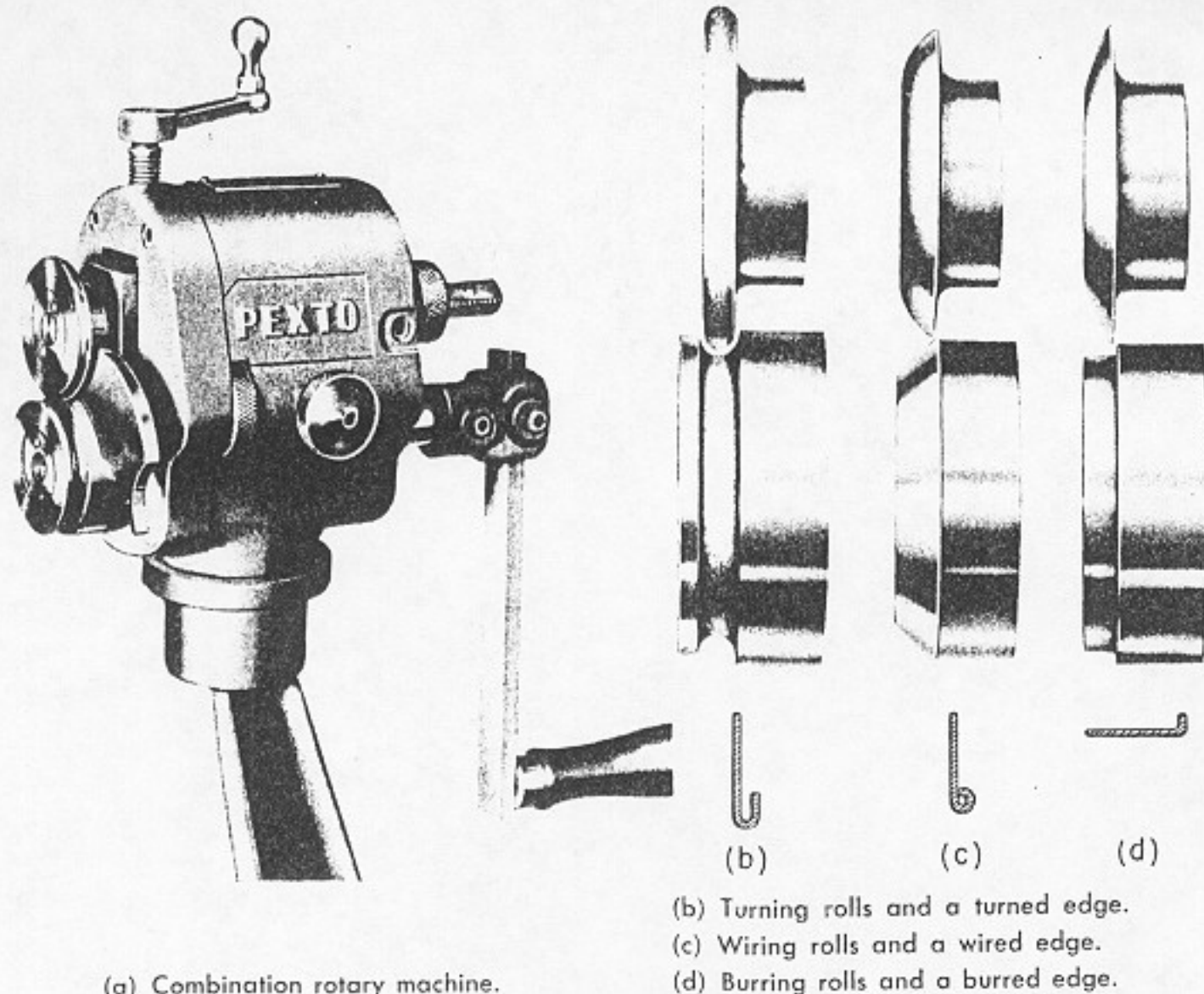


Fig. 7-9. Combination rotary machine for turning, wiring, and burring the edges of sheet metal. (Courtesy Peck, Stow and Wilcox Co.)

against the gage. Lower the upper roll onto the metal by turning the crankscrew, making a slight depression. With the left hand, hold the metal against the gage while turning the crank handle until the metal has made one complete revolution. Lower the upper roll a little more, then tip the metal slightly upward. Turn the crank handle until the metal has made another revolution. Continue the lowering of the upper roll and the tilting up of the metal (see Fig. 7-10) until the edge has been turned.

Using a Combination Rotary Machine to Burr an Edge. Before attempting to burr an edge, check the combination rotary machine to make certain that the burring rolls are on it. If there

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is any doubt in your mind about the appearance of these rolls, study Fig. 7-9b. Now, set the gage on the machine to the width of the burr by measuring

from the gage to the inner edge of the upper roll. After doing this, lower the upper roll onto the metal by turning the crankscrew. Do not apply too much pressure, for it is possible to cut the metal with the upper roll. Steady the hand on the machine and turn the

crank handle. As the handle is turned, the disc will revolve between the thumb and fingers of the hand. It is a good practice to protect the hand from the sharp edge of the metal with a guard consisting of a V-shaped piece of metal. Continue turning the crank

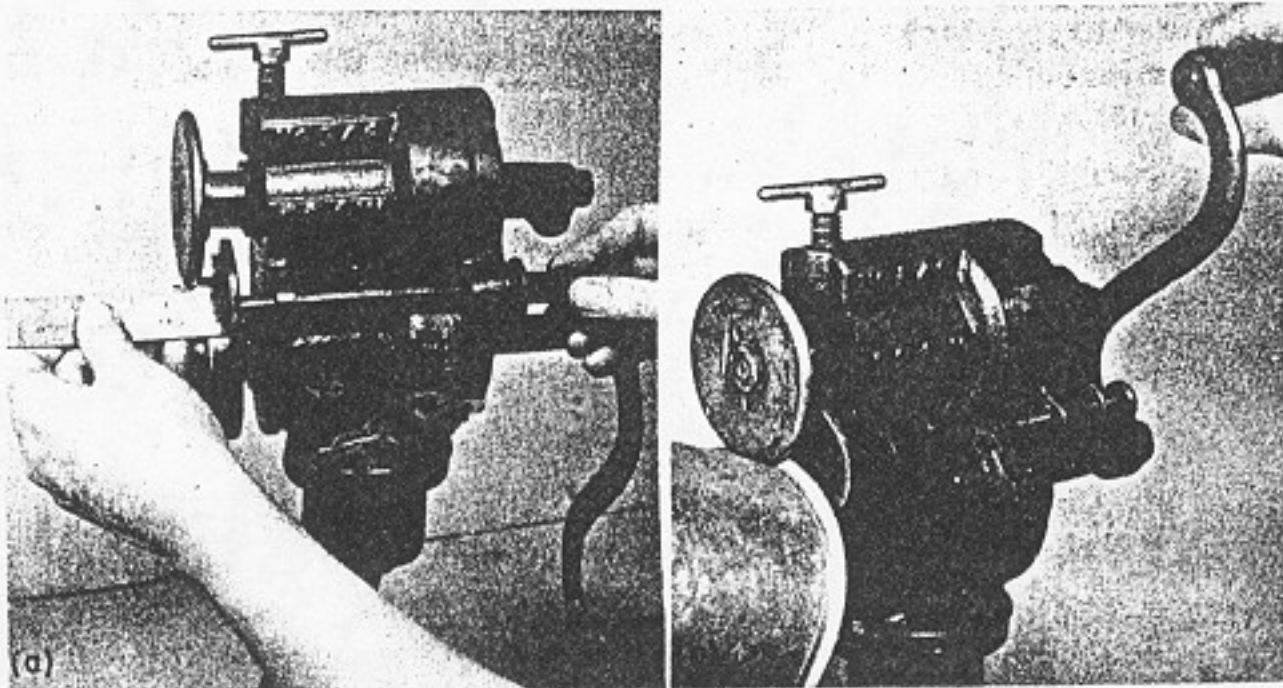


Fig. 7-10. The setting of the gage is done easily and accurately when a rule is used.

handle while at the same time raising the metal until the burr is formed.

Using a Combination Rotary Machine to Wire a Sheet Metal Edge. The edge must either be turned (see Fig. 7-10) or folded (see Fig. 7-7) for the size of the wire being used. After the edge has been prepared, place the wire, which has already been formed to the correct shape, in the turned or folded edge. Close the metal slightly around the wire with the pliers or a mallet (see Fig. 7-6e). After doing this, set the gage of the wiring machine by means of the adjusting screw until the upper roll just clears the outer edge of the wire. Hold the work against the gage and lower the upper roll onto the metal (see Fig. 7-8). Holding the metal in a horizontal position, turn the crank handle after each revolution of the metal, gradually lowering the upper roll. Continue this procedure until the metal is tightly wrapped around the wire. On the final revolution, tilt the object upward to about a 30-degree angle. This tends to push the edge of the metal under the wire.

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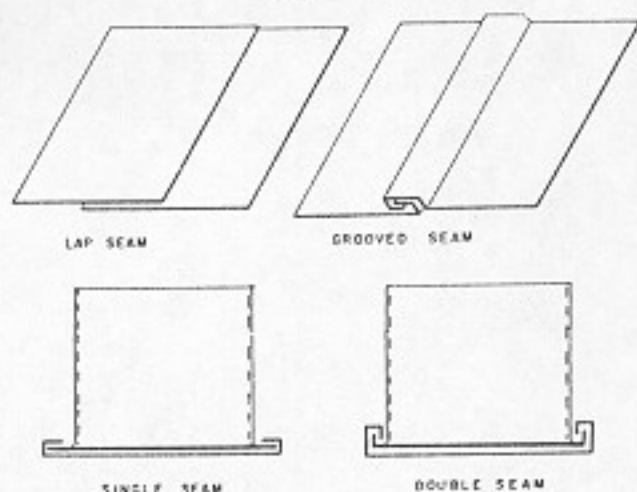


Fig. 7-11. Seams used in sheet metal work.

Seams Used in Sheet Metal Work

A seam is a lap or fold made on the edge of a piece of metal for the fastening of two pieces of sheet metal together. Seams may be made by (1) lapping one edge of the metal over another and fastening the lapped edges together by soldering or riveting; (2) folding the edge and hooking the folded edges together; or (3) locking the folded edges together with a hand

groover. After studying Fig. 7-11, you will better understand the different seams.

Lap Seams. Lap seams are made by placing one edge of the metal on top of the other. The amount of metal allowed for a lap seam is equal to the width of the lap. This amount is added to one of the two edges that are to be lapped to make a seam. In studying Fig. 7-12, you will notice that there are two types of lap seams, the plain lap and the corner lap seam. Either one of these seams must be fastened or held together by soldering or riveting. The lap seam is frequently used on small articles. The corner lap seam is the same as the lap seam except that it is made at the corner of any box-like project.

Grooved Seams. *Hand Groover.* The hand groover (see Fig. 7-13) is used for flattening and offsetting folded edges and to make a grooved or, as it is often referred to, a lock seam. The

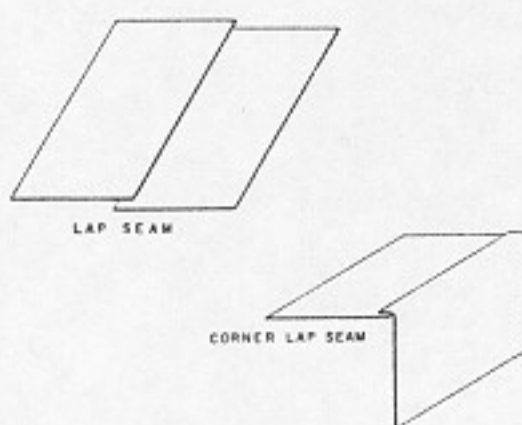


Fig. 7-12. The lap seam is the easiest to make and the simplest of the seams used in sheet metal work.

width of the seam is determined by the width of the fold and the width of the groove in the hand groover.

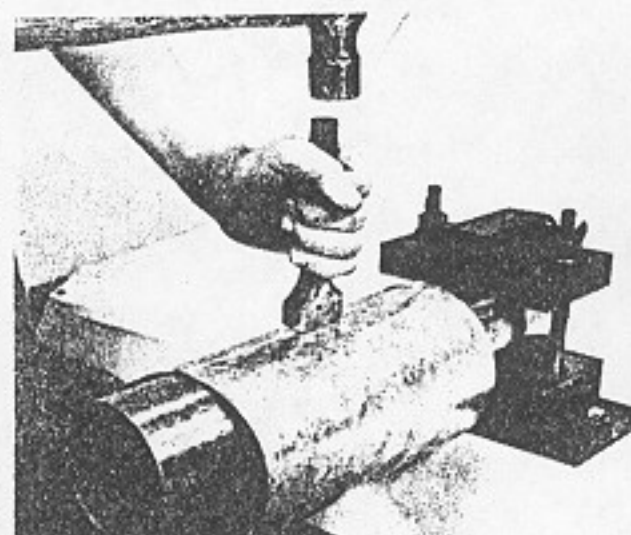
Making a Grooved Seam. To make a grooved or lock seam, first lay out along the two edges that are to be fastened together the amount of metal necessary to make the seam. The amount to be allowed for a grooved seam is three times the width of the seam. One-half of this amount is added to each side of the metal. To fold the two edges, follow the same procedure

as for making a single hem (see Fig. 7-3). When folding the metal, take care that one edge is folded toward one side of the metal and the other edge

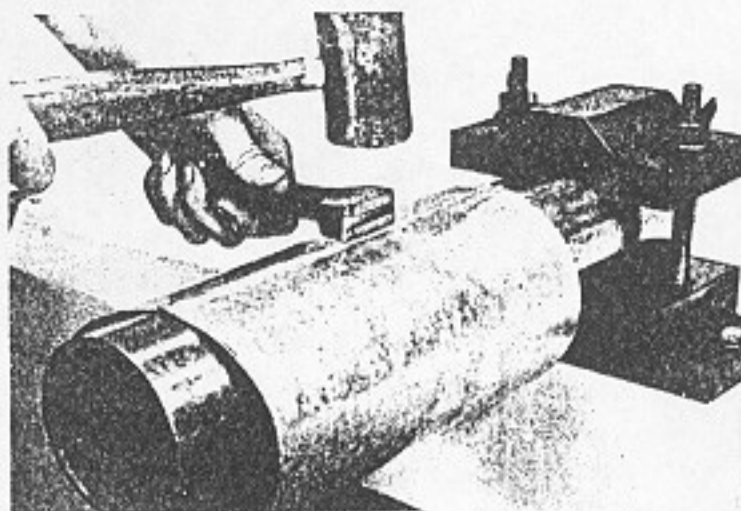
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Fig. 7-13. Hand Groover.



(a) Locking the seam with a hand groover.



(b) Smoothing the seam.



(c) Outside grooved seam.



(d) Inside grooved seam.

Fig. 7-14. Grooving a Seam.

is folded toward the opposite side. Then, hook the folded edges together. Hold the hooked edges on top of a stake or some other solid metal surface and flatten the seam with a mallet. Then, at one end of the seam place the groove of the hand groover over the folded edges as shown in Fig. 7-14a and strike the hand groover with a hammer. Repeat this same procedure at the other end of the seam. Now, groove the entire seam before flattening the seam with a mallet (or hand groover as in Fig. 7-14b). Grooved seams may be made outside (see Fig. 7-14c) or inside (see Fig. 7-14d).

Single Seam. The single seam, like the lap and the grooved seam, is used to fasten sheet metal together. However, its use is in the joining of bottoms onto square, rectangular, or cylindrical objects (see Fig. 7-15a), as well

as in the construction of tops and lids (see Fig. 7-15b).

To make a single seam, first make a flange or projecting edge on one edge of the body. On straight edges the flange may be made on the bar folder or by hand, whereas on cylindrical objects the flange is turned on a burring machine. After flanging the body, lay out the bottom. Remember that the bottom is as wide as the distance from the outside edge of the flange on one side of the body to the outside edge of the flange on the opposite side, plus twice the width of the flanges. Now, flange the bottom. After doing this, you are ready to set the body down into the flanged bottom. To finish the single seam, carefully bend the flange on the bottom over the flange on the body.

Double Seam. The double seam

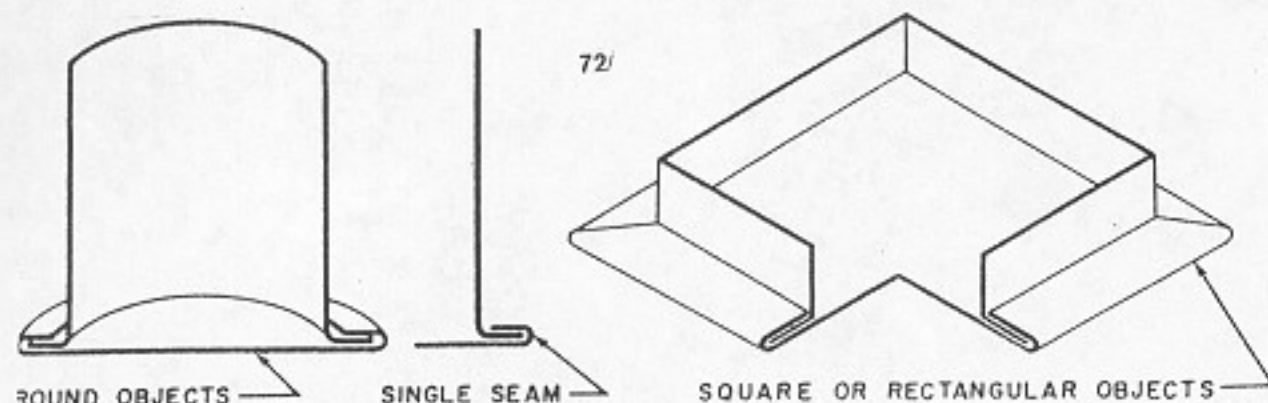


Fig. 7-15. Single Seams.

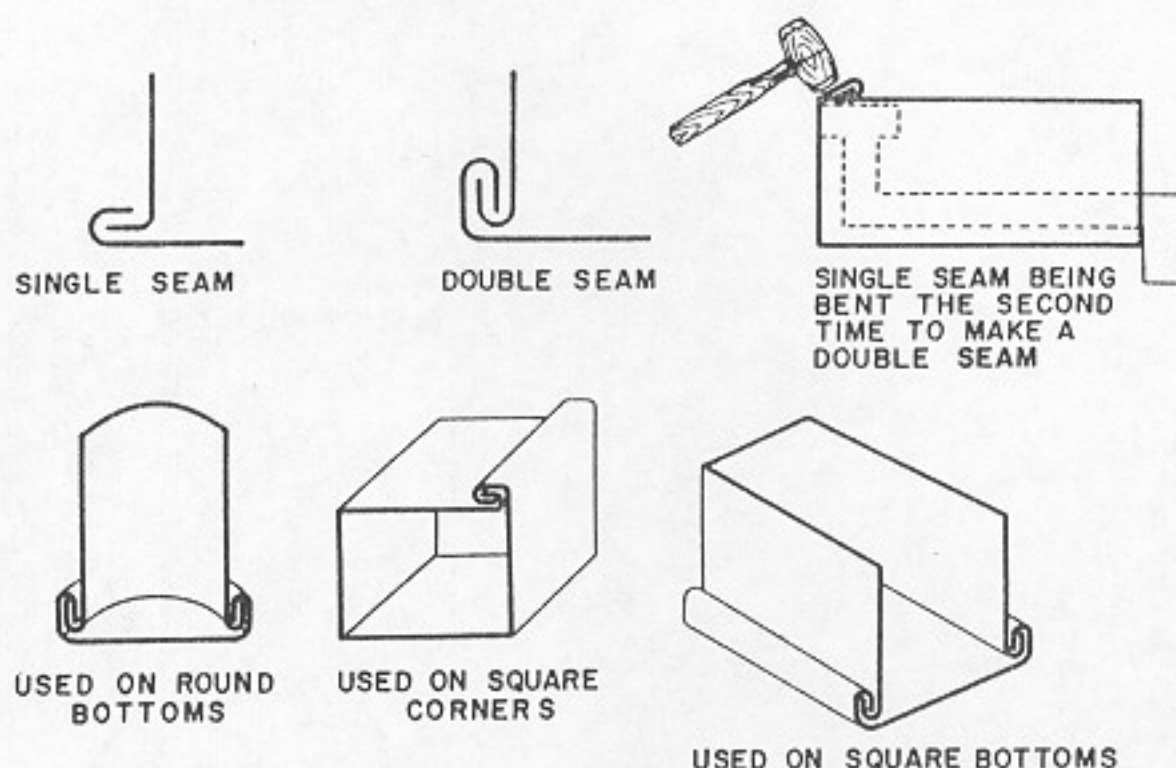


Fig. 7-16. The double seam adds strength and rigidity when used in sheet metal construction.

(see Fig. 7-16a) is a single seam that has been bent up against the side of the metal. It is a very strong seam that can be used on square corners (see Fig. 7-16b) as well as around bottoms. To make a double seam, first make a single seam and then fold this seam up against the body as shown in Fig. 7-16c.

Soldering

Soldering is the joining or holding together of pieces of metal with a soft metal alloy. Heat in some form and a



Fig. 7-17. Fusion Solder. (Courtesy Fusion Engineering.)

flux must be used to solder. Solder, a mixture of tin and lead, is soft and easily melted, and does not rust. When melted, it adheres readily to such metals as tin plate, copper, brass, and zinc. Solder is usually purchased in bar or wire form.

Fusion Solder. Fusion solder alloys are combinations of metal alloys, flux, and cleaning and tinning agents in paste form (see Fig. 7-17). To solder, apply the paste to the metal parts and apply heat with a torch; as the paste melts, it cleans, fluxes, and solders all in one operation.

Soldering Flux. Flux must be used on surfaces to be soldered. When solder is applied to metal, the surface must always be clean. Paint, rust, or dirt must be scraped off. A knife, file, or any scraping tool can be used. In addition, flux is spread over the surface. This further cleans the surface and breaks down the oxide that forms on the metal as it becomes hot. Different fluxes have been prepared for various metals. They can be purchased ready for use. Some fluxes are made for soldering several metals, whereas others

are made for only one. Sal ammoniac is generally used for tinning soldering coppers. Resin is effective on some metals that are scraped clean and bright. "Killed" acid (made by dissolving zinc in muriatic acid until it stops boiling), is good for zinc or galvanized iron. The druggist can prepare a pewter flux by mixing 10 drops of hydrochloric acid to an ounce of glycerine. Prepared paste fluxes usually work well on brass, copper, galvanized iron, and IC tin.

Heat for Soldering Coppers. There are two kinds of soldering coppers in general use. One is heated by a gas flame and the other by electricity. The electrical soldering copper operates on the same principal as an electric flat iron.

Soldering Coppers. The point of the soldering copper is used to melt solder and draw it to the desired place. It is usually made of copper, because this metal is easily heated and gives off heat readily. Soldering coppers are more commonly called soldering irons (see Fig. 7-18).

be difficult. A soldering copper covered with dirt or oxide will not give off so much heat as a tinned soldering copper.

To tin the point of a soldering copper, heat it to the proper temperature. This may be done in a furnace or in a stove, with a blow torch, or with anything that will provide sufficient heat. When the copper is sufficiently hot, the solder will melt and flow like a liquid. If the point is permitted to become red hot, it will not hold solder until it cools to the proper temperature.

If the point is covered with dirt or scale, it should be cleaned with a file. Cold soldering coppers are hard to file; therefore, they should always be heated before filing (see Fig. 7-19a). The point of the copper often becomes too blunt from filing, making soldering in corners difficult. When this happens, the copper should be heated and the point reshaped with a hammer. Since solder will not stick to a dirty copper, if it is smudged with soot from heating, it must be cleaned. This is usually done by rubbing it on a block

of sal ammoniac, dipping the point into a solution of sal ammoniac and water; or, as a last resort, wiping it with a piece of cloth.

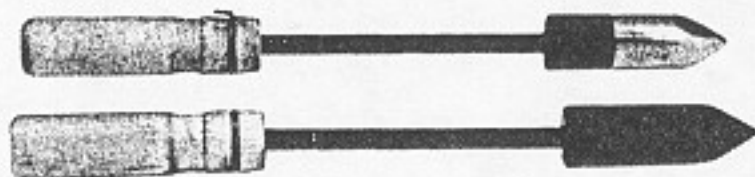
Now, with a clean hot soldering copper, you are ready to place a piece of soft solder on a block of sal ammoniac and rub the hot soldering copper on this block and in contact with the solder (see Fig. 7-19b). As soon as the point of the copper is clean, the solder will stick to it, making it look as bright and shiny as a new dime. If a liquid flux is used to clean the copper, the point should be quickly dipped in the solution before the solder is applied to it.

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Applying Solder with a Soldering Copper. To use a soldering copper to solder, it must be hot and well tinned and the metal to be soldered must be clean and must fit tightly together. Spread a small amount of soldering paste or flux on the joint (see Fig. 7-20a). Hold the hot, tinned, and clean soldering copper on the place to be soldered. When the metal becomes



(a) Electric soldering iron. (Courtesy American Electric Heater Co.)



(b) Soldering coppers.

Fig. 7-18. Soldering Coppers.

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Tinning the Soldering Copper. To use a soldering copper successfully, it is necessary that the point be tinned. This means that about three-quarters of an inch of the point is plated with a layer of solder. When the point is properly tinned, it will draw the melted solder along a seam as a magnet draws iron. If the copper is not properly tinned, soldering will

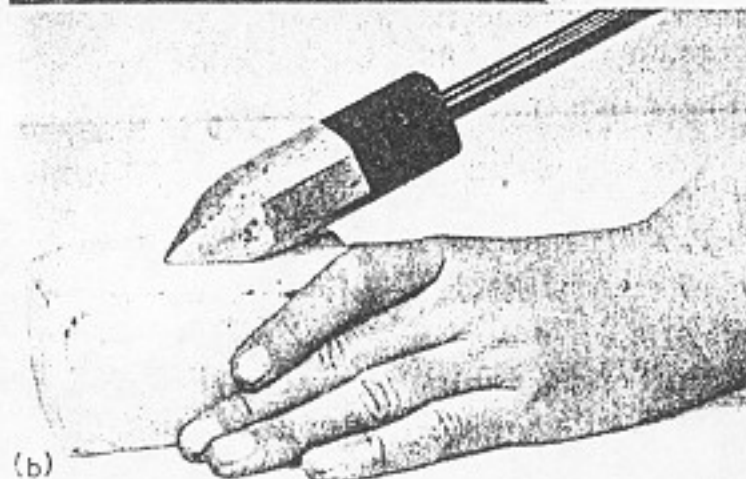
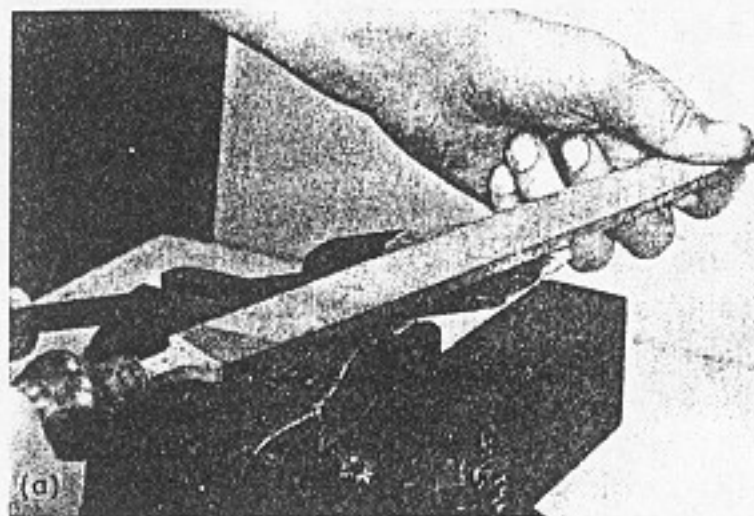
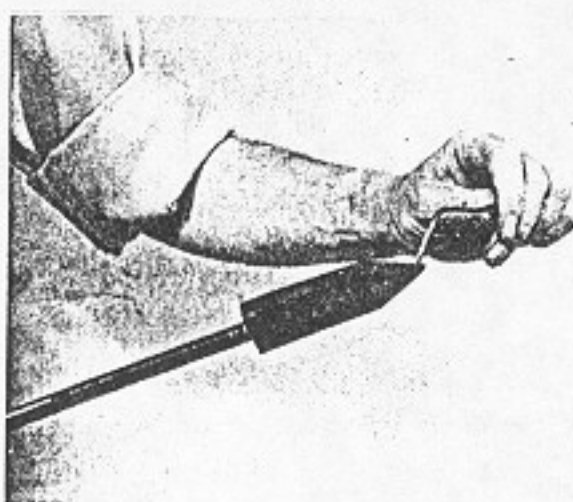


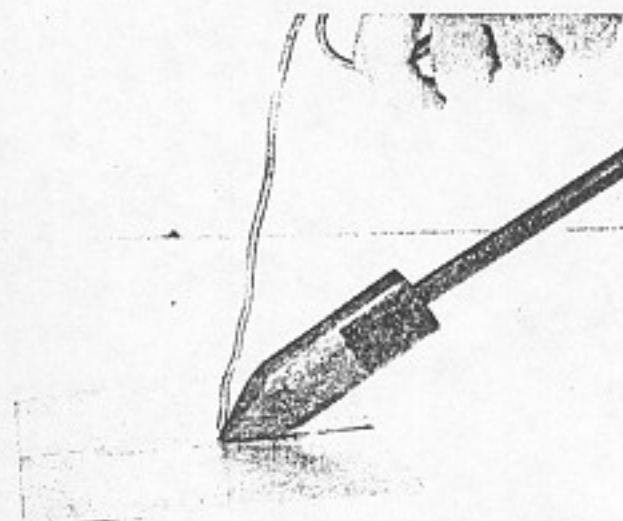
Fig. 7-19. For ease of soldering, the soldering copper should always be well shaped and tinned.



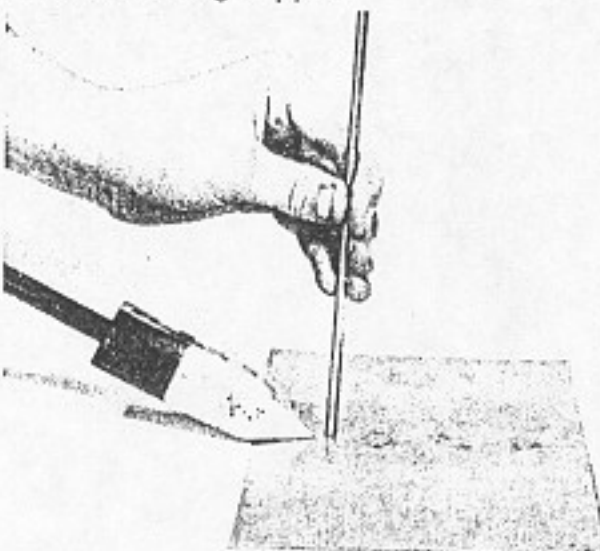
(a) Applying flux to the seam.



(b) Applying solder to a cleaned and tinned soldering copper.



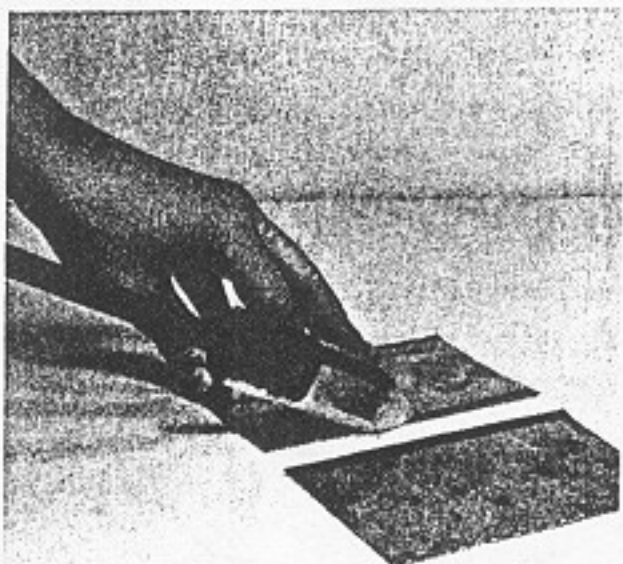
(c) Soldering the seam.



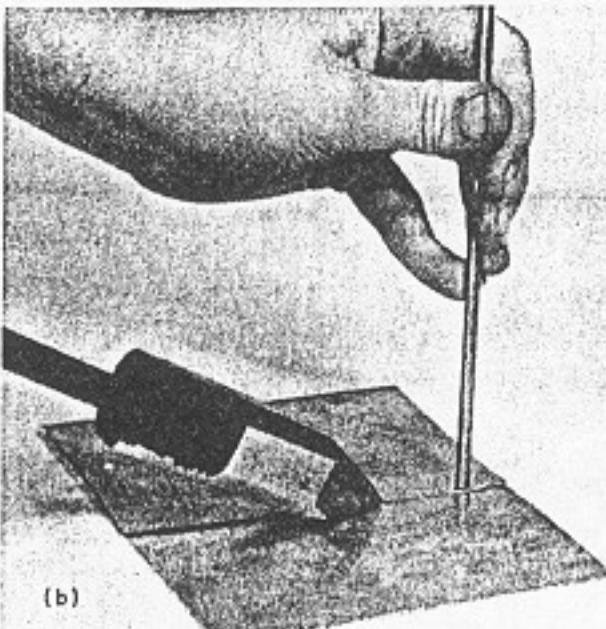
(d) Tacking a seam before soldering.

Fig. 7-20. In soldering, the soldering copper should always be kept hot enough to cause the solder to flow like a liquid.

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(a)



(b)

Fig. 7-21. The sweat soldering method is generally used when it is important that solder should not show on the outside of the joint.

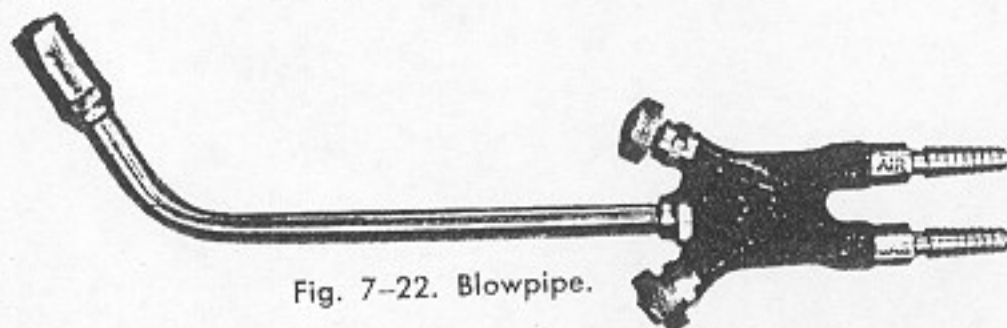


Fig. 7-22. Blowpipe.

hot, apply the solder, which will flow onto and between the metal parts being joined together. Another method is to pick up a little solder on the point of the copper before applying it to the metal (see Fig. 7-20b). Slowly move the soldering copper along the joint, applying solder as needed (see Fig. 7-20c). Hold the work together until the solder turns a dull color. Often seams are tacked together with solder before the actual soldering (see Fig. 7-20d). **NOTE:** Soldering cannot be done with a cool, dirty soldering copper. Before you attempt to solder and immediately after you have removed the soldering copper from the furnace, wipe the tinned tip clean or dip it in a cleaning solution of sal ammoniac and water. The tip should be bright and shiny before it is applied to the metal.

Sweat Soldering. For sweat soldering, coat with solder or tin one side of each of the two pieces to be joined together (see Fig. 7-21a). Place the two tinned surfaces together. Heat the seam with a hot soldering copper. The two pieces must be held together while the heat is being applied (see Fig. 7-21b). When the solder between the two pieces is melted, remove the heat or draw it along the seam. Pressure should be held on the metal parts until the molten solder hardens.

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Blowpipe. Blowpipes (see Fig. 7-22) provide another way to melt solder by using an open flame to heat the metal being soldered to the melting point of solder. A blowpipe is used in metal craft and jewelry work. The flame is usually produced by a mixture of gas and compressed air.

Using a Blowpipe for Soldering. When you solder with a blowpipe, the metal to be soldered must be clean and the parts should fit tightly together. Spread a small amount of soldering paste or flux on joint. Apply the flame from the blowpipe on the location to be soldered (see Fig. 7-23). When the metal becomes hot, apply the solder.

Using Wire to Hold Pieces of

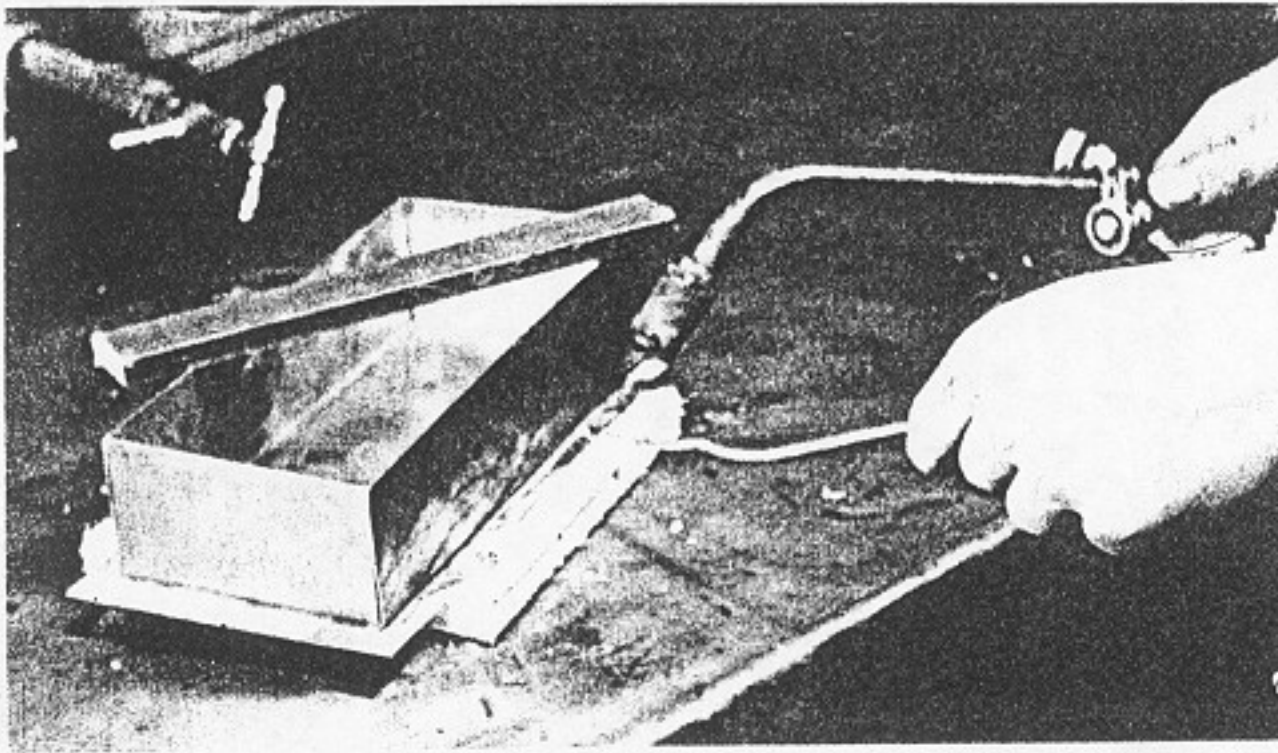


Fig. 7-23. When a blowpipe is used, the metal itself actually becomes the soldering copper. For this reason it is difficult to hold. Set it on an asbestos pad or hold it together with a weight, or wire.

Metal Together for Soldering. Sometimes pieces of metal can be soldered together more easily if they are held together with wire. This is especially true in craft work. After wiring, it is often possible to hold the entire article over a Bunsen burner for heating the metal (see Fig. 7-24). Hold it there until the metal is hot enough to melt solder, and then apply solder to the joint.

Soldering Aluminum. The soft aluminums, such as 2S0 and 3S0, can be easily joined together by soldering with A-500 aluminum alloy fusion solder. The two edges to be joined together are first thoroughly cleaned with steel wool and then given a liberal coating of solder. The two edges are then placed together and wired or held in place with weights. Heat is then applied outside the joint with a blow-

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pipe or a welding torch. The flame must be moved about continually to prevent melting the metal and to assure uniform heating. Soon the solder will start to boil or bubble. Watch closely, for as soon as white smoke appears, you must direct the flame onto the joint. At this moment the solder will flow into the joint. After the metal

Fig. 7-24. Soft iron binding wire, gage 18 and 24, can be used to hold pieces of metal together while they are being soldered.

has cooled, clean the joint with water and a brush or steel wool.

Rivets—Kind and Sizes

Rivets are used to fasten two or more pieces of metal together. They are made of soft metal such as soft iron, brass, copper, and aluminum, that can be flattened and headed by the force of hammer blows. The more common shapes of rivet heads are the countersunk, flat, and round head (see Fig. 7-25a). The size of a rivet is designated by the length and diameter of the rivet shank, which is the cylindrical part under the head. The lengths given for flat and round head rivets do not include the head. Measure only the length of the shank under the head to determine the length of such rivets. The length given for the countersunk

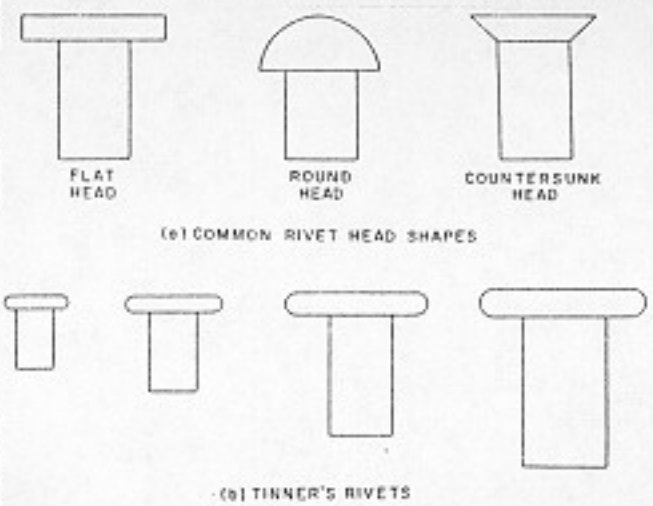
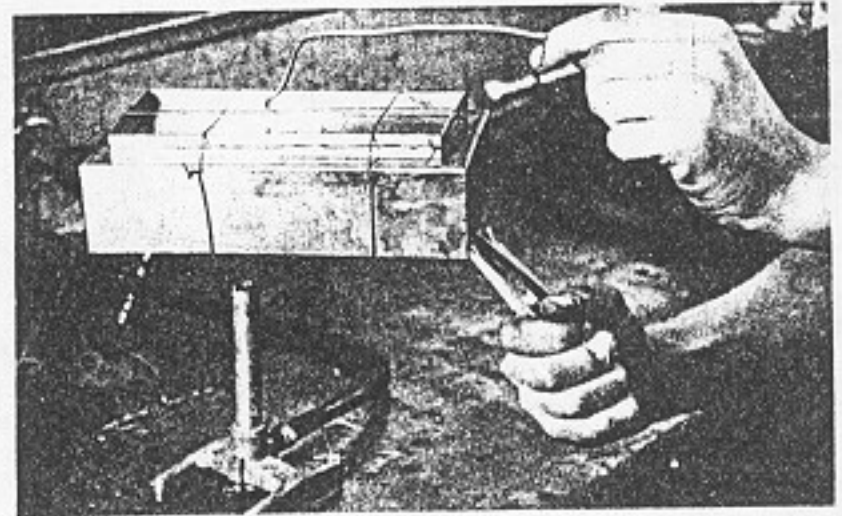


Fig. 7-25. Rivets.

head rivet includes the head and the shank.

When riveting two or more pieces of metal, the correct length of rivet must be used. To determine the proper length of a flat or round head rivet,



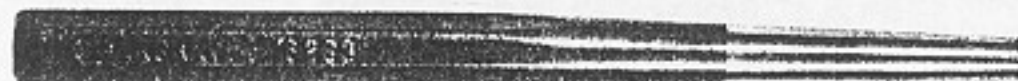
measure the thickness of the metal to be riveted and add to this one and one-half times the diameter of the rivet. For countersunk rivets, measure the thickness of the metal and add to this about three-fourths of the diameter of the rivet. Tinner's rivet sizes are by

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weight per 1,000 rivets (see Fig. 7-25b). The size of these rivets can range from 6 ounces for 1,000 rivets up to 18 pounds for 1,000 rivets.

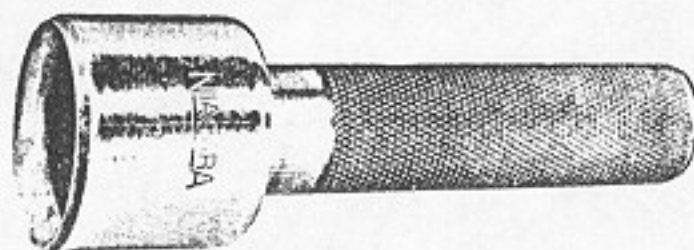
Solid and Hollow Punches. Holes are seldom drilled in sheet metal; they are usually punched through. Small holes are punched with a solid punch. Larger holes up to three inches in diameter are punched with a hollow punch (see Fig. 7-26).

Using a Solid or Hollow Punch for Punching Holes in Sheet Metal. To punch a hole with a solid punch, you



(a) Solid punch.

Fig. 7-26. Solid and Hollow Punches.
(Courtesy Cincinnati Tool Co. and
Niagara Machine & Tool Works.)



(b) Hollow punch.

must first select the proper size punch. The hole that this punch makes must fit the rivet selected to fasten the pieces of sheet metal together. Lay out the location for the rivet hole. Place this location on top of a block of lead or on the end grain of a piece of hard wood. Set the solid punch on the location for the punched hole and strike the end of the solid punch with a hammer (see Fig. 7-27a), driving the

punch through the metal and into the lead or wood block. It is possible to punch holes through more than one thickness of sheet metal at a time. Holes over three-eighths of an inch

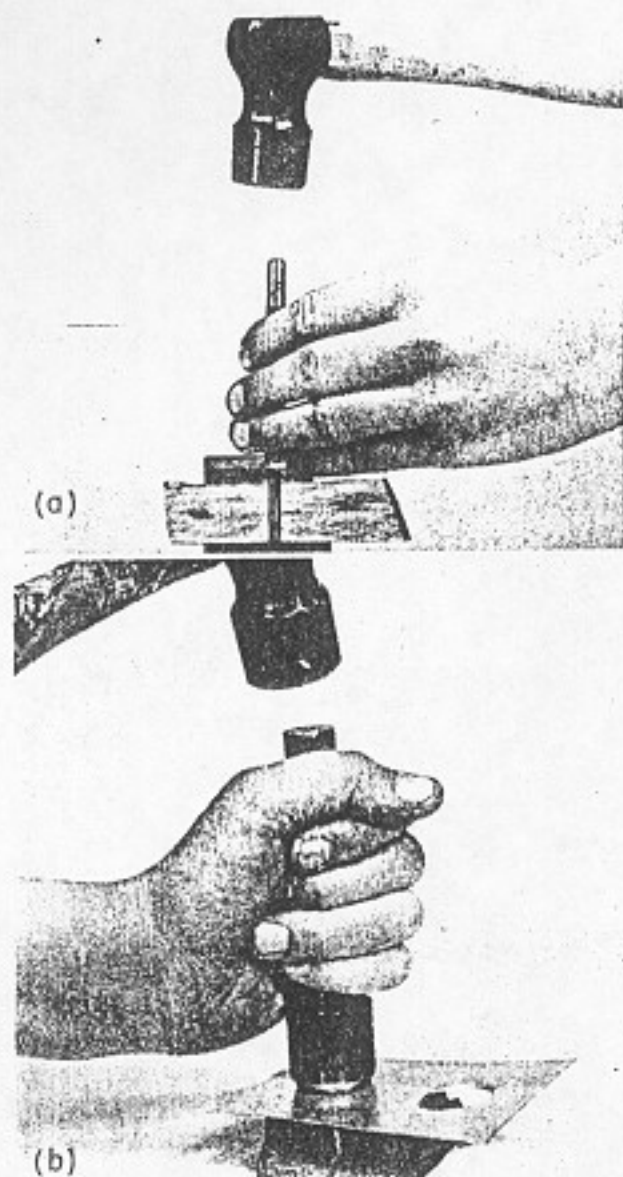


Fig. 7-27. Holes in light-gage metal are made with a punch. Afterwards it is necessary to flatten the bulge or bend that is formed around the edge of the hole.

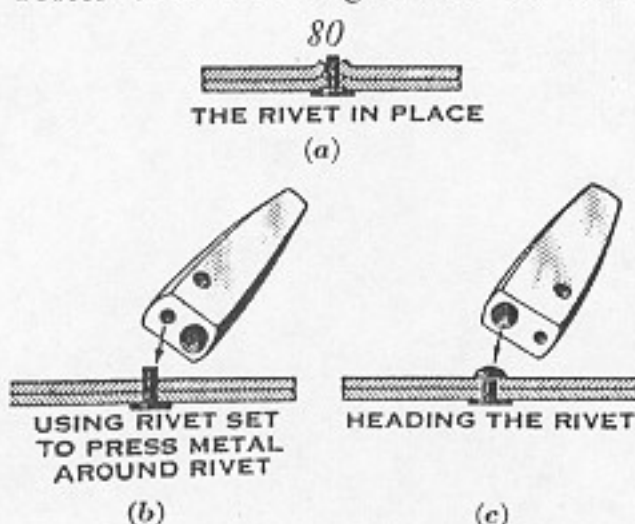


Fig. 7-28. (a) The rivet in place; (b) using a rivet set to press the metal around the rivet; (c) heading the rivet. Rivets should not be located too close to the edge of the metal. They should be at least two times the diameter of the rivets away from the edge. (From Household Mechanics by Bedell & Gardner, copyright 1945, D. Van Nostrand Company, Inc.)

in diameter are usually made with a hollow punch. The hollow punch is operated the same as a solid punch (see Fig. 7-27b).

Rivet Set. The rivet set, as used by the sheet metal worker (see Fig. 7-28), performs two different duties. One is the pressing of the metal around the rivet, and the other is the forming of a round head on the rivet, which is called heading the rivet.

Using Rivets to Fasten Together Two or More Pieces of Sheet Metal. To rivet metal together, insert the rivet into the hole that has been punched in the sheet metal (see Fig.

7-28a). Hold the head of the rivet on a solid metal surface, such as a pounding block or an anvil. Place the hole that is in the face of the rivet set over the rivet shank. With a hammer, strike the head of the rivet set a sharp, hard blow, pressing the metal around the rivet (see Fig. 7-28b), and then strike the rivet a few sharp, hard blows with a hammer. This sets the rivet and starts to form a head on it. To head the rivet, hold the spherical depression that is in the face of the rivet set on the flattened rivet. Hit the head of the rivet set a few blows with the hammer, forming a nice round head on the rivet (see Fig. 7-28c).

Welding—Oxyacetylene and Arc

Learning to weld is not difficult. With practice and experience, almost anyone can become a good welder. In simple terms, welding means placing two pieces of metal together and heating the place where they join until the edges become molten and flow together to become one piece. This joint is called a seam.

An oxygen and acetylene welding outfit as shown in Fig. 7-29 consists of an oxygen regulator and an acetylene regulator. The duty of the regulators is to control the flow of gases from the tanks through the hose and out the end of the welding torch tip.

In use, the oxygen regulator is adjusted to read from 4 to 8 pounds of pressure and the acetylene to from 3 to 6 pounds. With the regulators adjusted, open the torch acetylene valve and light the acetylene at the tip with a spark lighter. (Always wear welding goggles when welding. Be sure to cover your eyes with the goggles before lighting the torch.)

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As soon as the torch is lighted, slowly open the oxygen valve, mixing the oxygen and acetylene together and producing a flame of three distinct colors of burning gases. These colors are in an outer flame, an intermediate

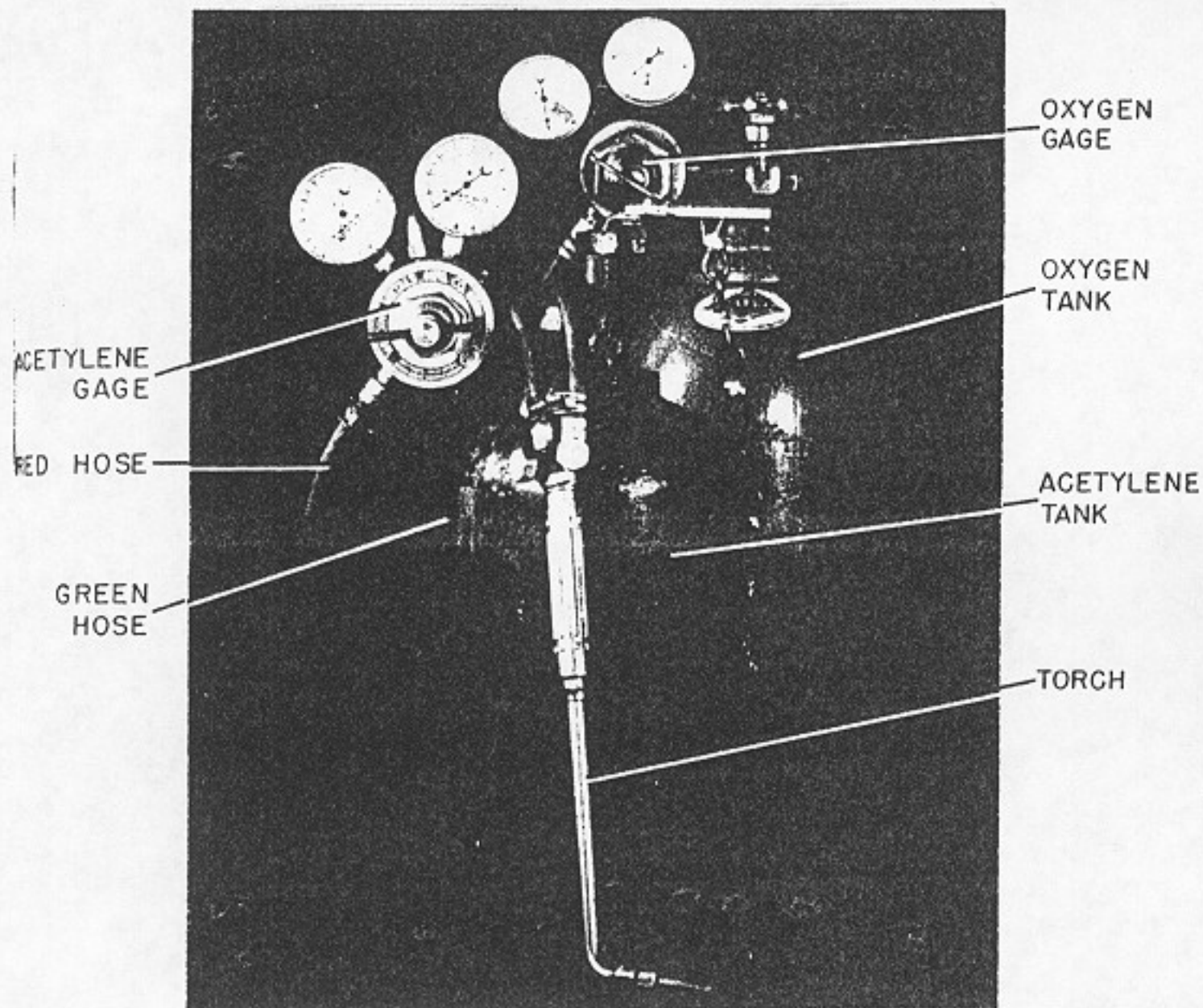


Fig. 7-29. An oxyacetylene welding outfit assembled for welding.

cone of flame, and an inner bright cone of flame. As you turn on more oxygen, the intermediate cone becomes shorter until it finally disappears. This leaves only the outer flame and a very distinct inner cone. When the flame is adjusted to this appearance, it is burning with equal parts of acetylene and oxygen, and is producing what is known as a neutral flame. This is the flame that is used for almost all welding jobs. With the torch adjusted to the neutral flame, you are ready to start welding.

Welding a Seam. When first attempting to weld, the beginner should

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get the feel of the torch and be able to recognize the neutral flame. After this, the edges of the metal that are going to be welded together should be cleaned with a wire brush or with emery cloth. Again, dirty or rusty metals are difficult to join. Now place

the parts on a brick or a metal surface with the two edges butted together. Holding the torch loosely and the tip at an angle to the metal, lower the center cone of the flame to within one-sixteenth of an inch of the parts and at a point farthest away from you.

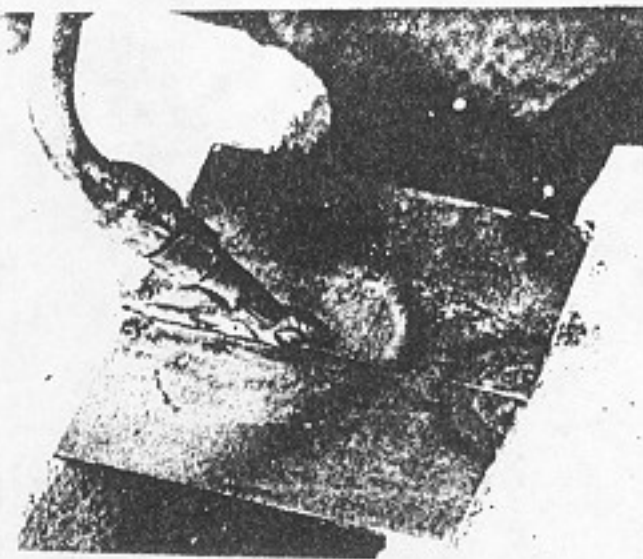


Fig. 7-30. A welded joint of the type shown above is widely used in ornamental iron work.

At this point, heat the two edges until they begin to melt together and form a small puddle of molten metal (see Fig. 7-30). Move the flame slowly toward you with a rotating or zigzag motion along the two edges of the metal. You can weld only as fast as the metal melts. Continue this motion until you almost reach the edge closest

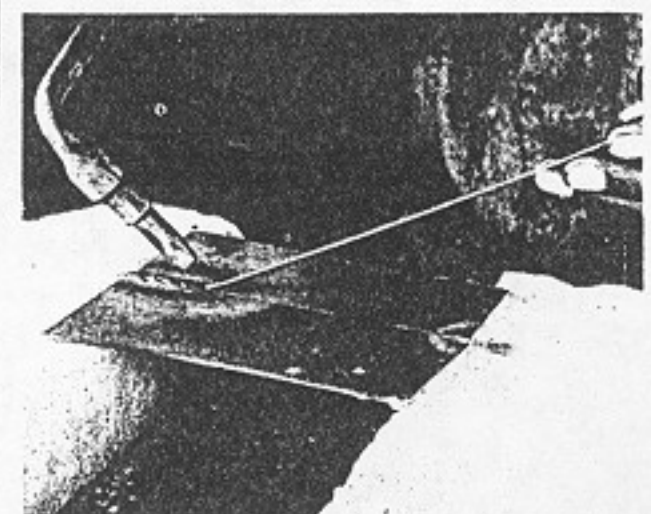


Fig. 7-31. The addition of metal from a filler rod, as shown here, makes possible a stronger joint.

to you. Just before reaching this edge, lift the flame a little to prevent burning through the metal at the edge.

Welding a Seam Using a Filler Rod. A filler rod is used in welding to add metal to the weld to produce what is called a *bead*. This additional metal adds strength to the weld. About the only difference in welding when using a filler rod is that you are actually adding metal to the weld. The weld is started by creating a puddle of molten metal. The tip end of the filler rod is then lowered into the molten puddle (see Fig. 7-31). The rod is melted with the flame of the torch tip as well as with the heat of the molten metal in the puddle. Add enough filler rod until a raised bead of metal appears and then raise the rod out of the puddle. Continue adding the metal to the puddle and raising the rod out of it as you move the torch along the edges of the metals that you are welding together. Continue this for the full length of the weld being made. Again,

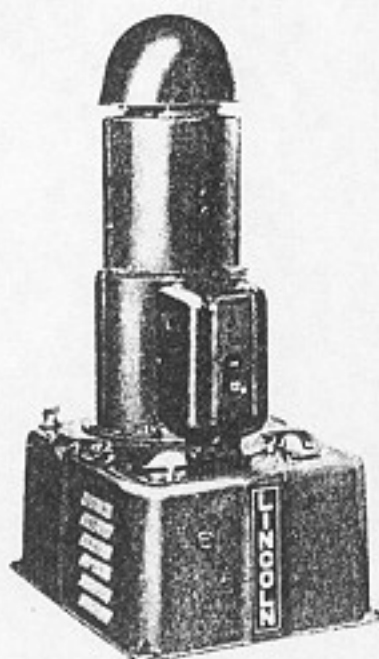
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just before reaching the edge of the plate nearest you, raise the flame of the torch a little higher to avoid burning a hole in the metal right at the edge of the plate.

Arc Welding. Arc welding is a method of welding that uses an electric arc to produce the heat for melting the metal. There are two general types of arc welders. One supplies an alternating current for welding and is commonly known as an AC welder. The AC welder (see Fig. 7-32a) is a transformer welder, which means that the transformer is connected to either a 110-volt circuit or to a 220-volt circuit, depending on the size of the welder. This device increases the current so that it provides enough heat to melt the metal being welded. The other type of welding unit supplies direct current for welding and is known as a DC welder (see Fig. 7-32b). This machine usually contains a generator, which manufactures the



(a) AC welder.



(b) DC welder.

Fig. 7-32. Arc Welders. (Courtesy Lincoln Electric Co.)

current needed for welding. This generator is usually turned or driven by an electric motor or a gasoline engine.

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When a DC or AC arc welding machine is used, the metal being welded must become a part of the electrical circuit from the machine. This is usually accomplished by having two heavy rubber covered cables attached to the machine terminals. One cable is known as the ground cable and is fastened to the metal to be welded. The other cable is called the electrode cable. To it is attached an electrode holder, into which is placed a welding

rod (see Fig. 7-32). As the welding rod is brought close to the metals to be welded, an arc of electricity jumps from the welding rod to the metals. The flash from the arc is very bright. For this reason a shield with dark colored glass in it is always used to cover the eyes and face before striking the arc. The heat of this arc melts the metal and the welding rod at the same time. The metal from the welding rod drops into the molten puddle of metal and joins the two pieces together. This

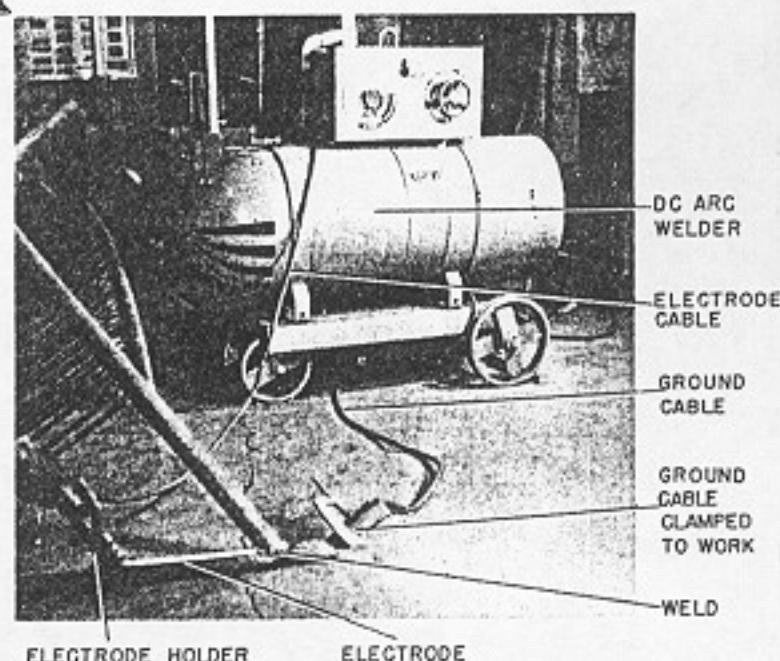


Fig. 7-33. Arc welding is used on heavy metal.

joint, if made properly, is generally stronger than the metal itself.

Questions

1. Name the three kinds of edges used on sheet metal and describe each.
2. How do we figure the amount of metal to be allowed for a wired edge?
3. The combination rotary machine can be used for what three sheet metal operations?
4. What is a seam and why is it used?
5. Explain how to figure the allowance of metal necessary for a grooved seam.
6. What is a notch and why must it be used in sheet metal work?
7. What two methods may be used to wire an edge?
8. Solder is composed of what two kinds of metal?
9. What is the purpose of flux?
10. Why are soldering coppers made of copper?

11. Why is it necessary to use sal ammoniac when tinning a soldering copper? Can another material be used to tin a soldering copper?
12. Why is it necessary to have the metal being soldered clean and to have each piece touching the other?
13. Name the different kinds of rivets.
14. Give the reason for cleaning the metal at the edge where it is to be welded.
15. What type of flame should be used to do almost all types of welding?
16. Why is a filler rod added to a weld?

C H A P T E R 8

Decorating, Polishing, and Finishing

This chapter covers the following subjects:

Abrasives for Polishing, 85 • Polishing Metal Surfaces by Machine, 86 • Preserving the Finish, 90 • Pickling, 91 • Enameling on Copper, 92 • Etching, 93 • Hammer Marking, 96 • Chasing Tools, 97 • Matting Tools, 99 • Fluting Tools, 100 • Dapping Punch and Dapping Die, 103 • Metal Finishing, 103

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Metal surfaces can be made very beautiful by proper finishing and tooling. Most metals have a natural color and texture that can be brought out by polishing. Additional attractive effects can be secured with chemicals that change the color of the metal. Many attractive designs can be achieved by the use of tools that mark the surface.

Abrasives for Polishing

Abrasive Cloths. Abrasive cloths do to metal what sandpaper does to wood. One such abrasive cloth is emery cloth. It is made by glueing a material called emery onto a cloth backing. Emery is a natural abrasive. Another abrasive used like emery is man-made and is called aluminum oxide. Aluminum oxide is better than emery for it is harder and therefore retains its sharp cutting edges longer. It is also made in much finer grades than emery cloth. These fine grains, such as those used on number 320

aluminum oxide cloth, are especially adaptable for polishing nonferrous metals by hand. The different grades of abrasive fineness are designated by numbers. There are nine different grades of emery cloth. Number 3/0 is the finest and number 3 is the coarsest. There are many more different grades of aluminum oxide cloth. A number 4 cloth will be quite coarse. Here, too, as the number becomes larger, such as 50 and 500, the grain becomes finer.

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Steel Wool. Steel wool is satisfactory for polishing and cleaning of metal by hand. It is made in several grades of fineness. This is indicated by the fineness of the steel shreds from which the steel wool is made. These grades are designated by numbers. The finest is number 0000, and number 3 is the coarsest, with 6 grades in between. Numbers 000 and 00 are the grades most commonly used for the polishing of nonferrous metals. Steel wool is especially useful on ir-

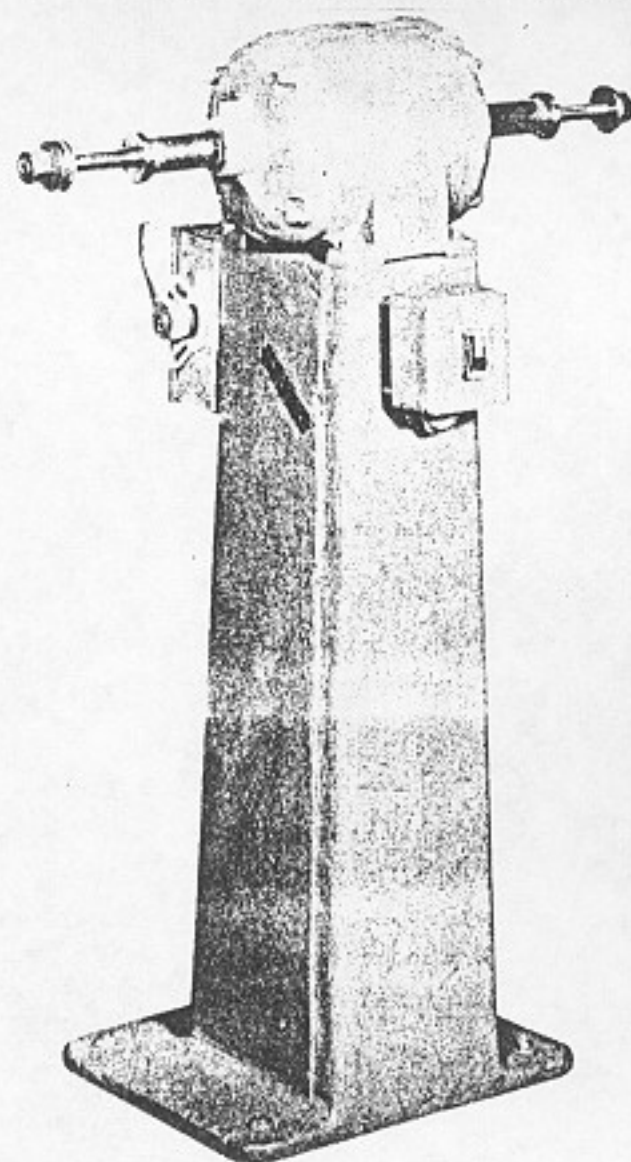


Fig. 8-1. Polishing Lathe. (Courtesy Frederic B. Stevens, Inc.)

regular and hammer-marked surfaces. However, it will not remove deep scratches. These should be removed with fine emery or aluminum oxide cloth. To polish a surface with steel wool, it is proper to form the wool into a firm ball. Then rub with a straight backward and forward motion until the desired finish is obtained.

Polishing Metal Surfaces by Machine

The smooth, lustrous, and highly glossy finish on a metal surface can be produced much more easily by a machine. Buffing wheels can be mounted on a drill press, a lathe, or a bench grinder. For safety and health, buffing wheels should be used on a polishing lathe equipped with a dust collector. The lint from the buffing wheel and the polishing compound is harmful if breathed into the lungs.

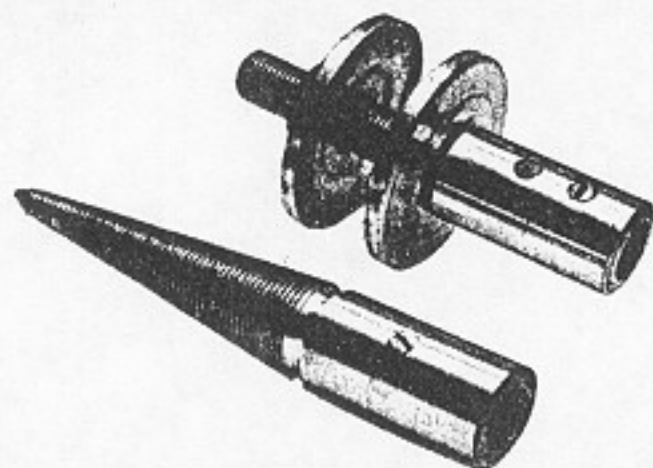
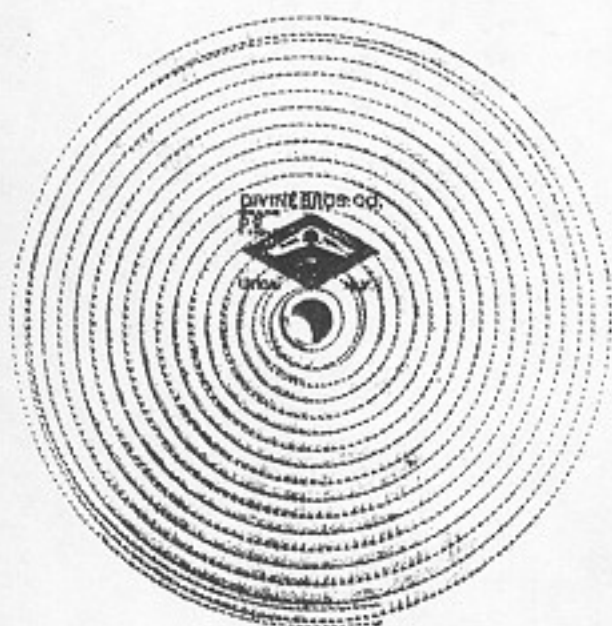


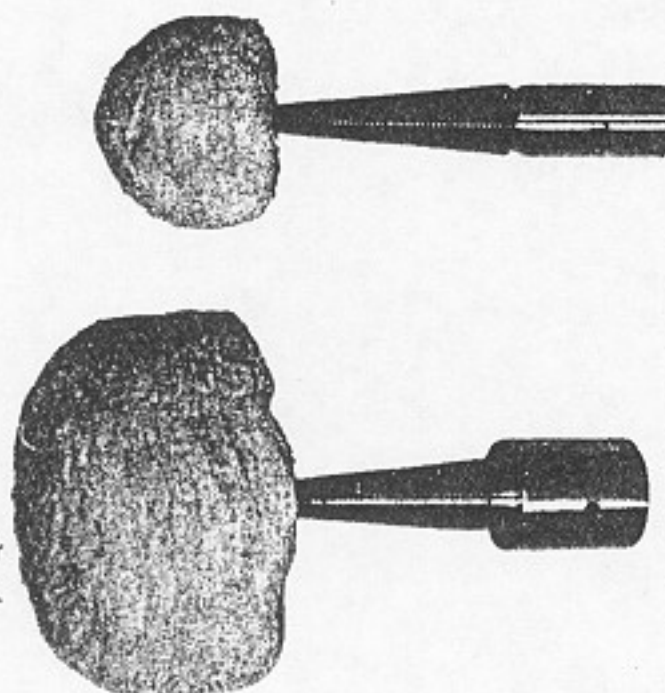
Fig. 8-2. Polishing and Buffing Spindles. (a) Grinding and polishing wheel arbor. (b) Tapered buffing spindle used with hard-center buffing wheels.

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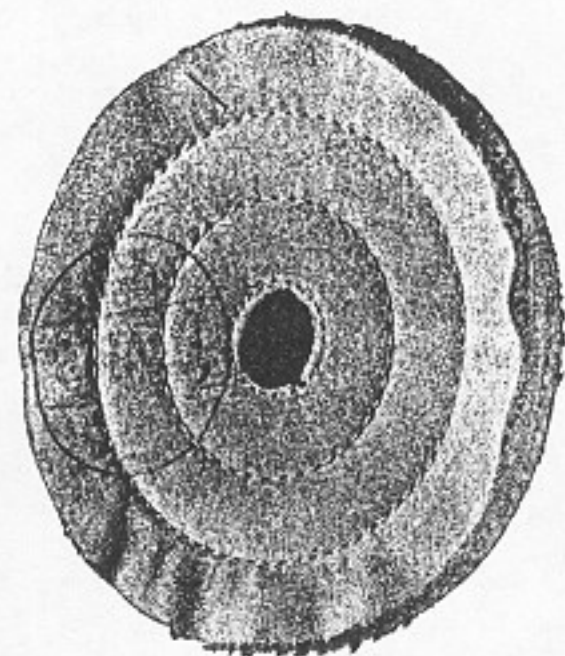


(a) Spirally sewed buffing wheel, used for polishing and cutting down of the metal. (Courtesy Frederic B. Stevens, Inc.)

(b) Loose or sewed-once buffing wheel, used for final finishing or coloring (high polish) of the metal. (Courtesy Divine Bros. Co.)



(d) Goblet buffs, used for buffing inside of bowls.



(c) Concentric sewed buffing wheel, widely used in jewelry work. (Courtesy Frederic B. Stevens, Inc.)

Fig. 8-3. Buffing Wheels.

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Polishing Lathes. The polishing industry uses many large and elaborate

polishing lathes. However, for school use, an ordinary grinder or electric motor with proper bearings and sufficient power can be substituted for a regular polishing lathe (see Fig. 8-1).

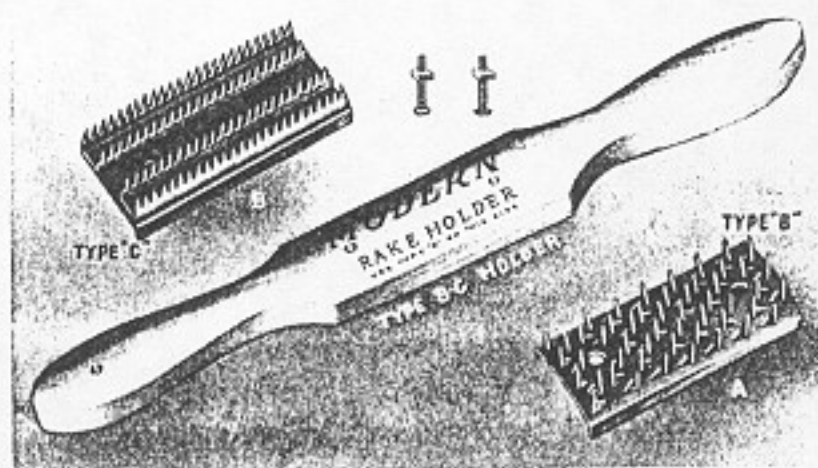
Polishing and Buffing Spindles. Polishing and buffing spindles are attachments for electric motors (see Fig. 8-2). They enable you to convert an ordinary electric motor into a polishing lathe.

Buffing Wheels. Most buffing wheels are made from layers of circularly cut muslin. Enough single layers are placed one on top of the other to build up a thickness of from about one-fourth to three-eighths of an inch. Some different types and shapes of muslin buffing wheels are shown in Fig. 8-3. However, buffing wheels may also be made from cotton flannel, woolen cloth, chamois, canvas, sheepskin, felt, and different kinds of leather.

Buffing and Polishing Compositions. Buffing and polishing compositions are gritty substances (mild abrasives) in cake form. They usually consist of a mixture of a bonding agent such as tallow or oil, chemicals, and the grit, which is the cutting agent or abrasive. Many different cutting agents are used, such as emery, crocus, lime, tripoli, and others. The bond holds the abrasive in cake form, making it possible for the composition to stick to a revolving buffing wheel. At the same time, the material acts as a lubricant during polishing.

Greaseless Compounds. The greaseless compounds do not have a grease base. Basically, they are a compound

Fig. 8-4. Wheel Rake. (a) For raking loose buffing wheels. (b) For raking sewed buffing wheels. (c) Handle for rakes. (Courtesy The Manderscheid Co.)



of glue and a sharp abrasive. When applied to a clean buffing wheel, the glue and abrasive stick and dry, forming a dry, greaseless surface. This surface cuts quickly and can be used for the cutting down of the metal surface, as well as for polishing. Greaseless compounds are made in various grades, of which coarse, medium, and fine are the most commonly used.

Double-Duty or Cut-and-Color Compositions. The double-duty compositions, as their name implies, perform two operations at once by finishing a metal surface in one opera-

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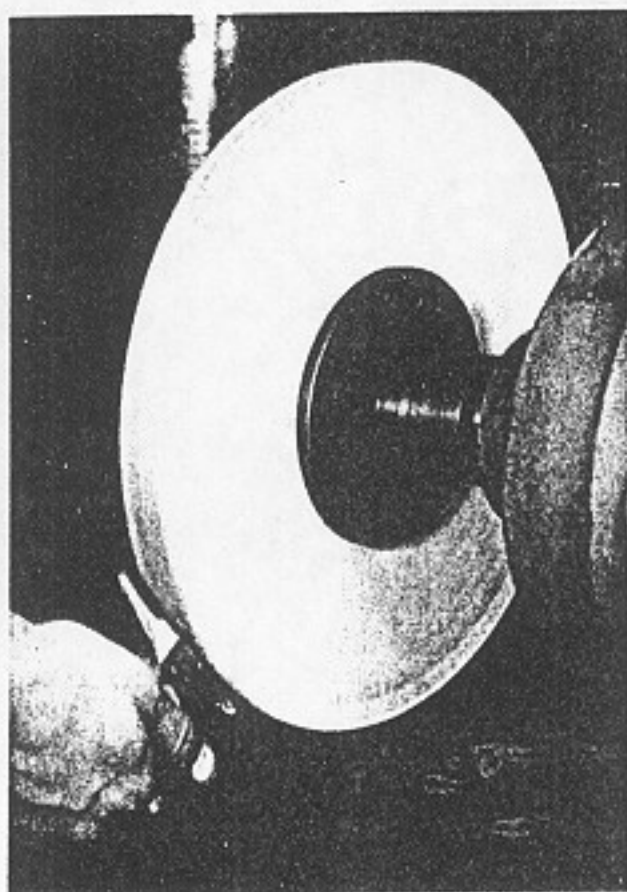


Fig. 8-5. With a spiral sewed buffing wheel, polished surfaces can be obtained on castings as well as on the light-gage metals.

tion, instead of in two. They are a combination composition that is made for both cutting down the metal and for coloring it or producing a high luster. A very beautiful polished surface may be obtained on copper or brass when buffed with this composition.

Chrome Buffing Composition. The compositions that are made for the polishing of chrome are also excellent for the polishing of aluminum. Another advantage in using a chrome

buffing composition is that it can be used successfully on the same buffing wheels that have been used for polishing with a double-duty composition. This saves having a separate set of wheels for each type of composition.

Wheel Rakes. Wheel rakes (see Fig. 8-4) recondition and shape the faces of the buffing and polishing wheels. A proper wheel surface is needed for efficient polishing, buffing, or coloring.

Using a Wheel Rake to Clean a Buffing Wheel. To recondition the working surface of a buffing wheel, hold the rake against the face of the buffing wheel and move it back and forth. Stop when the buffing wheel has been thoroughly cleaned. The cleaning of buffing wheels is necessary since through use they become loaded. This means that they become filled with buffing compositions and metal that has been cut away during polishing.

Buffing and Polishing Operations. The polishing of a metal surface with power-driven equipment is done by holding the metal surface against a revolving buffing wheel that has been charged with a buffing composition (see Fig. 8-5).

For the fast cutting down of the surface to remove scratches, a spirally sewed buffing wheel is used with a greaseless compound. This type of material should never be used on a

buffing wheel that has had a grease-base composition applied to it, for the glue in the greaseless compound will not stick to a buffing wheel that has grease on it. Following this, to obtain a high luster or color, which is the term employed in the polishing industry, a loose buffing wheel would be

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used with a double-duty composition for copper or brass and with a chrome buffing composition for aluminum (see Fig. 8-6).

Both the greaseless and the double-duty or chrome compositions may be used on either a sewed or a loose buff. The selection of the buffing wheel used is governed by the results that the polisher expects. For example, a soft satin finish is obtained on copper, brass, or aluminum if a fine grade of greaseless compound is used on a loose buffing wheel.

To polish a metal surface, select the composition to be used and apply it to the revolving buffing wheel. Then apply the metal to the buffing wheel with a downward wiping motion, never up against the direction of the revolving wheel. A good, fast polishing action is obtained when considerable pressure is applied each time the metal is brought into contact with the buffing wheel.

Black streaks or deposits of the buffing composition on the metal surface during polishing indicates that there

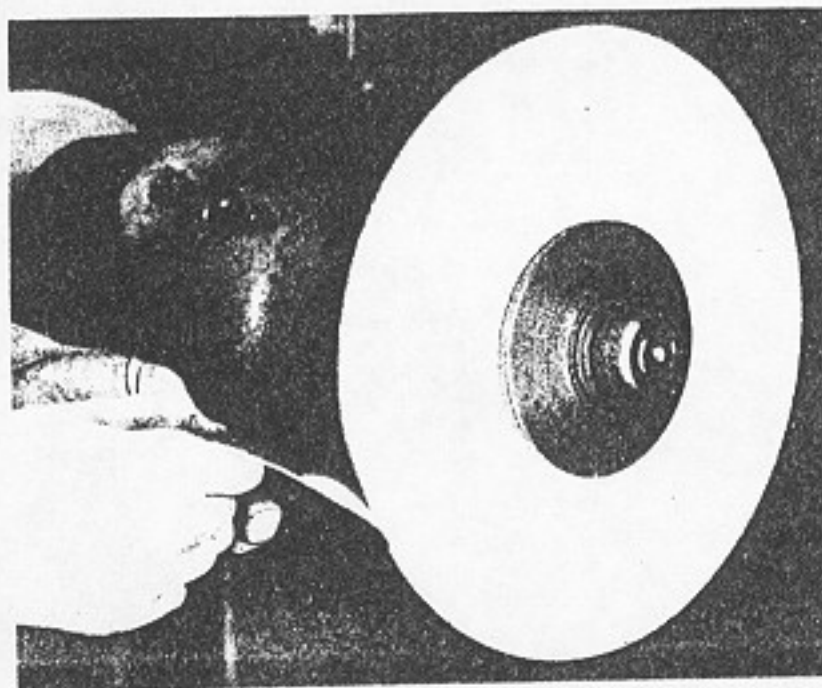


Fig. 8-6. Coloring with loose buffing wheels is the final finishing of a metal surface; it brings out the natural "color" or inherent beauty of the metal.

is either too much composition on the buffing wheel or that not enough pressure is being applied against the wheel with the metal.

A good, safe practice to follow in buffing is to place the metal below the center of the wheel. Hold it in such a way that no sharp corners or edges can become caught in the rapidly revolving buffing wheel.

Preserving the Finish

A coating of lacquer or wax may be applied to the metal to preserve the polished surface. First all grease from the polishing or buffing materials and all fingerprints must be removed. This can be done by washing the metal with very hot soap and water. Dry it with a clean, soft cloth, being careful not to touch the surface with

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your fingers. Handle it with a cloth or with clean cotton gloves. Be certain that no lint remains.

Polished or colored surfaces of copper and brass should be preserved with a protective coating of lacquer, glass wax, or wax. Without such protection, the polished surfaces may soon become dull through oxidization.

Lacquer Thinner. Lacquer thinner is a solvent for lacquer. It is used to thin lacquer that is too thick for spraying or brushing, as well as for cleaning brushes or other devices used for lacquering.

Using Lacquer to Preserve a Polished Surface. There are two types of lacquer, one for spraying and the other for brushing. Brushing lacquer is applied to a clean, dry surface with a soft camel's hair brush. Apply the lacquer as rapidly as possible with long, steady strokes. If the lacquer dries cloudy instead of clear, remove it with lacquer thinner and try again, following the same procedure.

Using Wax to Preserve a Polished Metal Surface. Wax or Glass Wax may be used as a protective coating for polished articles. A coating of

wax will not preserve the finish for so long a period of time as lacquer. Wax is generally applied to the metal surface with a piece of cloth. After drying, it is rubbed vigorously with a clean, soft piece of cloth, which will bring out the sheen or polish.

Pickling

It is very important for the surface of the metal to be chemically clean before you attempt to do any design work on it. Wiping with a rag or brushing with emery cloth will not do. The most effective way to clean metal is called *pickling*. This means that the item to be cleaned is immersed in a solution of sulphuric acid and water. Preparing the pickling solution requires special care and should be done only by an experienced person. The pickling solution is strong enough to burn your fingers and ruin your clothing.

A satisfactory pickling solution is made by putting two gallons of water in an earthen or glass jar and adding one and a half pints of sulphuric acid. **CAUTION: ALWAYS ADD ACID TO THE WATER.** The metal may be put in the pickling solution with a pair of wooden tongs. Ordinarily, a few minutes of immersion is all that is necessary. Do not breathe the fumes that arise. Then remove the metal and wash it immediately in running water. The cleaning process can be done better and faster if the pickling solution is warm.

Enameling on Copper

Copper enameling is the fusing by heat of a powdered material onto a piece of metal to form a beautiful glassy surface. The powdered material, called enamel, is a special mixture of powdered glass.

The essential equipment required consists of a kiln or a torch capable of heating metal to about 1,500 degrees Fahrenheit. Most of the required tools can be found in the shop and some

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even in your kitchen at home. The kitchen implements that might come in handy are a pancake turner, short and long metal spatulas, a sieve or a tea strainer, and a salt shaker. The hand tools are files, tongs, hack saws, tweezers, tin snips, ball peen hammers, some fine steel wool, and oil stones.

It is best that your first project for enameling be of flat or shallow design, such as a dish spun or raised from 18-gage copper. Once the project is ready, clean it with number 000 steel wool. Be most careful to keep your fingers off the cleaned surface. Then dip the copper in a pickling solution for a few minutes. Remove it



Fig. 8-7. Sift the enamel as evenly as possible onto the metal. This should be done over a piece of paper so that the unused enamel may be saved. Always work in such a way that you will not breathe into your lungs any of the fine particles of enamel.

and wash it in clear, cold water and dry it thoroughly. **CAUTION: WHEN USING THE PICKLING SOLUTION, DO NOT BREATHE THE FUMES FROM IT OR GET IT ON YOUR HANDS OR CLOTHES.**

The next step is to apply a coating of gum tragacanth to the surface to be enameled. Gum tragacanth may be purchased from your druggist in a dry leaf form. Break and grind the leaf into a powder. Then stir one teaspoon-

ful of the powder into one cup of water. Allow this mixture to stand for about 12 hours. When ready to use, stir in some more water until the gum reaches a creamy consistency. Coat the side of the dish that is to be enameled with the gum solution. You are then ready to sprinkle the enamel through the tea strainer (see Fig. 8-7) evenly over the copper until a layer about one thirty-second of an inch deep has been obtained. Set the project to one side until it is dry. This usually takes from five to fifteen minutes. Next, place the metal on a planche, which is nothing more than heavy wire mesh screen bent like this . The planche holds the metal off the bottom of the kiln, thereby permitting the heat to circulate completely around the project. The metal is now ready for heating. This may be done by a torch (see Fig. 8-8a) for small articles or in a kiln (see Fig. 8-8b) pre-heated to 1,500 degrees Fahrenheit, if one is available.

The metal and the enamel will soon become red hot. At this temperature, the enamel will melt and form a film over the metal. When the enamel has

completely melted to a smooth surface, the metal is removed from the heat and allowed to cool. If a design is to be applied, wait until your project is completely cool. Then dip it in the pickling solution, dry, and apply a second coat of gum and the next color of enamel before firing again. After the final firing, smooth all edges carefully with a file or oil stone so as not to chip the enamel. Polish the copper surface of the project and protect the polished copper with a coating of clear lacquer.

Etching

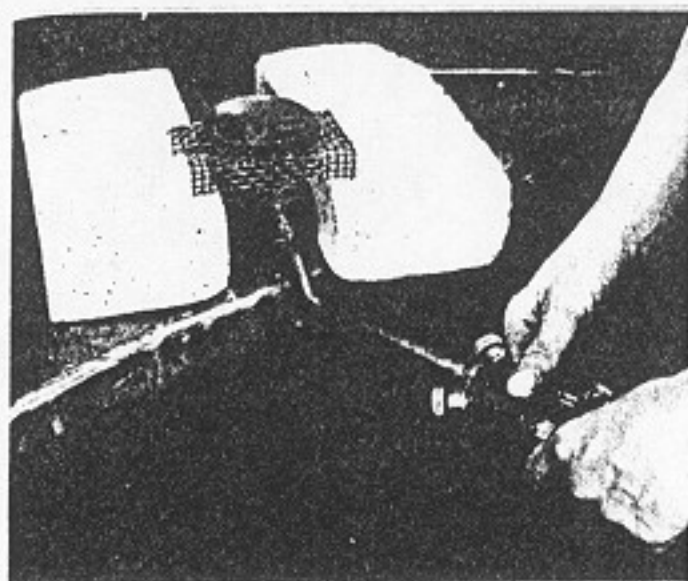
Etching is the process of producing a design by the chemical action of an acid on the metal. To etch a design, you must first protect those parts of the metal that should not be touched by the acid. This is done by painting the design with an acid-resisting material, such as asphaltum varnish. Before this material can be applied, however, the metal must be cleaned and the selected design transferred onto the metal.

To clean the metal, first remove all scratches with a fine grade of aluminum oxide cloth and polish the entire sur-

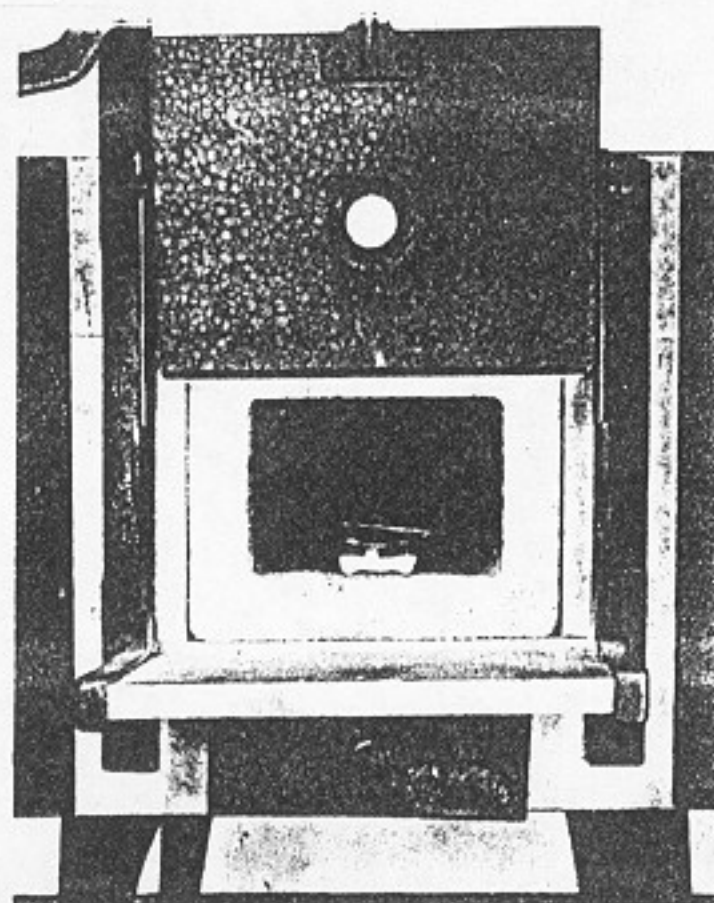
face with number 00 steel wool. Then wash the surface with white vinegar and let it dry. Be certain not to touch the surface to be etched with your fingers. Now, take the design you have selected and trace it onto a piece of

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tracing paper. Next, cut the tracing paper with the design on it to the exact size of the area to be etched. Take a piece of graphite paper and cut it to the same size as the tracing paper. Graphite paper should be used rather than carbon paper, for all types of carbons will not stick readily to a metal surface. Lay the graphite paper on the metal and place the design on top of the paper (see Fig. 8-9). Attach both to the metal with Scotch tape. Trace over the design with a hard lead pencil to transfer it onto the metal. Now remove the tracing and graphite paper from the metal and trace over the design outline on the metal with a scribe. It is now necessary to remove the graphite lines. This can be done with lacquer thinner, turpentine, or hot soap and water. The removal of the graphite lines eliminates the possibility of



(a) Torch method of enameling.



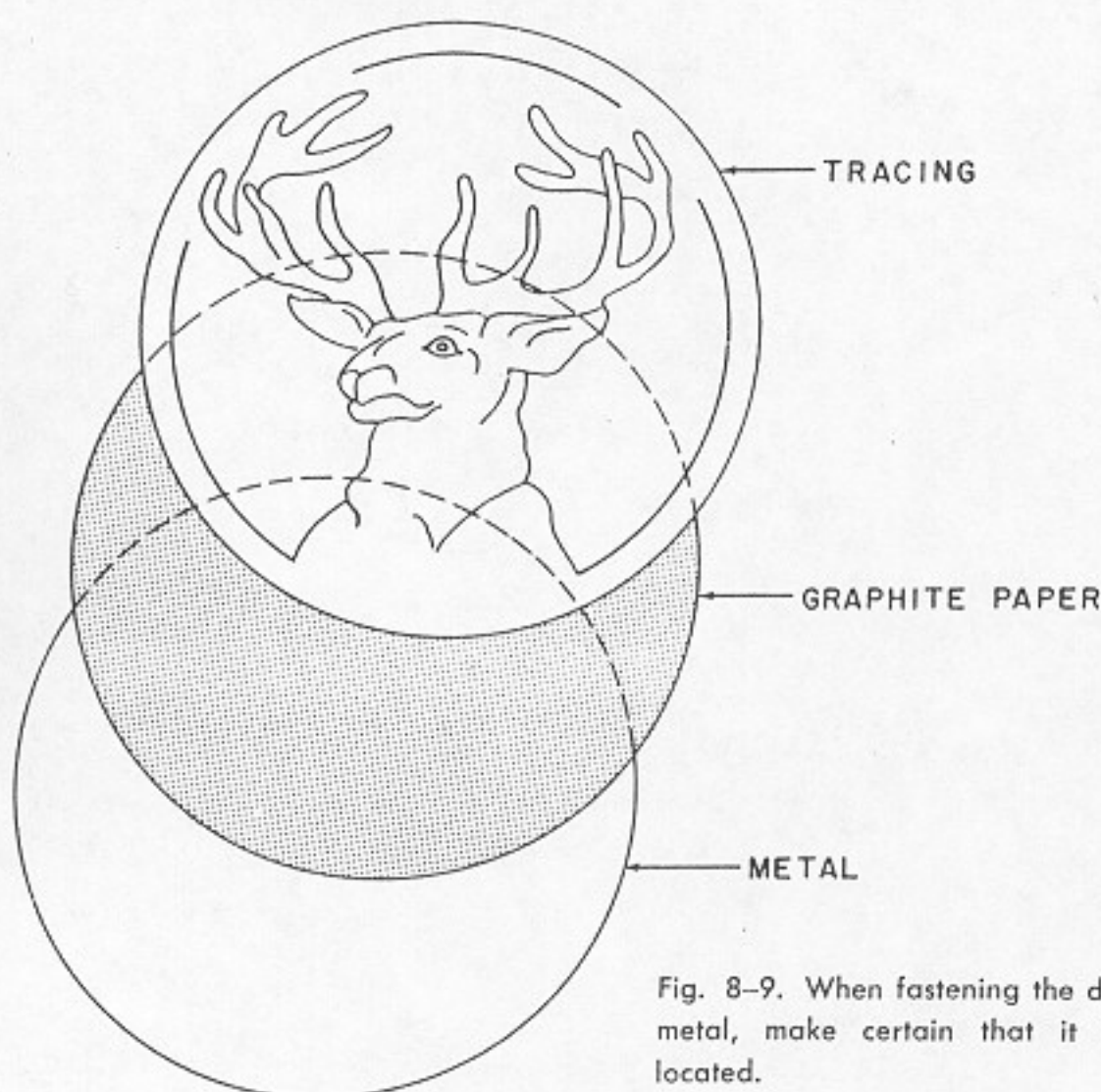
(b) Kiln.

Fig. 8-8. As the metal becomes red, the enamel will start to soften; at this point it looks rough. In about 15 seconds it will start to smooth out. When the enamel is melted and smooth, remove from the heat.

the acid's eating under the edges of the asphaltum and leaving an uneven etched edge or line.

A good grade of black asphaltum varnish can be used to resist either hydrochloric or nitric acid. It is most important, however, before you start to paint, to decide which portions of the design are to be shiny after etching and which parts are to be etched.

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Black out all the parts of the design that are not to be etched. A good pointed brush should be used. One heavy coat ought to be sufficient. If any brown spots show, they should be touched up, for the entire design should be a solid black. Vein lines are often a part of a design. When they are desired, it is necessary to black out the whole design. Then, before the

Fig. 8-9. When fastening the design to the metal, make certain that it is properly located.

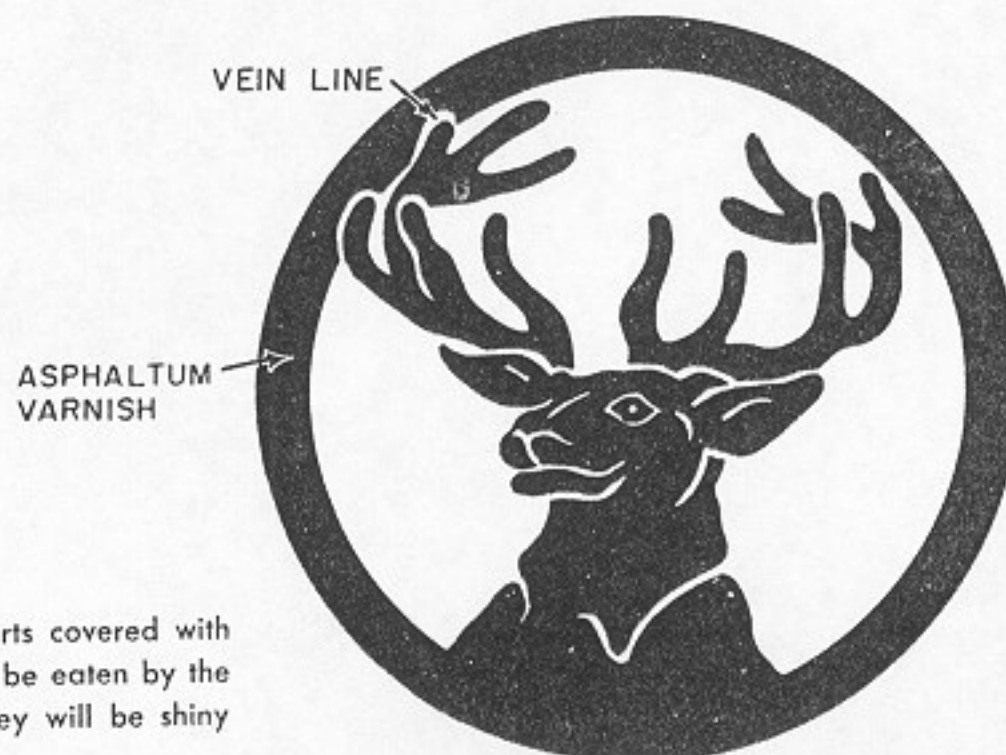


Fig. 8-10. The parts covered with asphaltum will not be eaten by the acid; therefore, they will be shiny after etching.

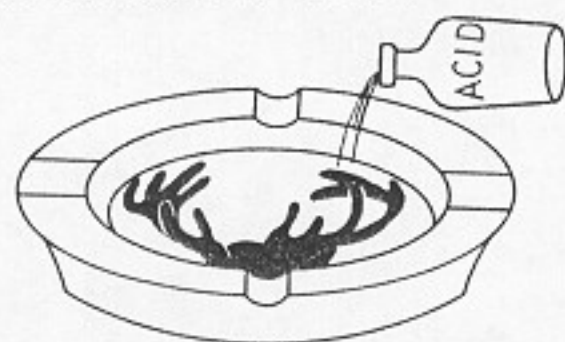
acid-resisting material hardens, take a stick sharpened to a point and draw in the vein lines (see Fig. 8-10). Clean the point of the stick after each stroke. Allow the asphaltum to dry until it is firm, but not hard and brittle. When etching aluminum, a solution of one part of hydrochloric acid to two parts of water is used. For etching copper or brass, a solution of two parts of water to one part of nitric acid is used. CAUTION: ALWAYS POUR ACID INTO THE WATER. NEVER POUR WATER INTO THE ACID. Acid should be stored and mixed only in glass or earthenware containers. When using acid, always work near an open window or in a well-ventilated area, since the acid action on the metal creates strong acid fumes.

When etching the bottom of bowls, the metal bowl may be used as the container for the etching solution (see Fig. 8-11a). In such instances, the asphaltum must be painted up to and over the edge of the bowl. Thus, a means is provided for pouring the etching solution out of the bowl after etching. For etching flat pieces, the etching solution is poured into a glass container and the metal is suspended or laid in the solution as in Fig. 8-11b. At this point the actual etching begins. Pour the etching solution into the prepared metal bowl, covering all the parts to be etched. After a few minutes, the acid will begin to boil and eat away at the

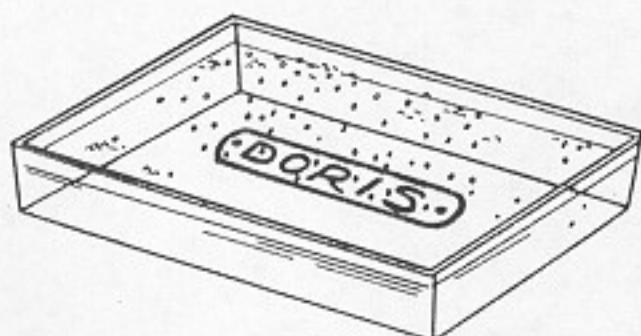
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unprotected parts of the metal. Usually the process of etching requires from 15 to 45 minutes. If the solution boils too fast, dilute it with water. An etching solution that is too strong works too fast and loosens or raises the edges of the asphaltum. When the design has been etched deep enough, pour off the etching solution. Then wash the metal under cold, running water until all traces of the solution have been removed. If the etching is not deep enough, the process is repeated by a second application of acid.

To remove the asphaltum from the metal after etching, cover it with tur-



(a)



(b)

Fig. 8-11. In (a), only enough acid is used to cover the design, but in (b) the entire article is placed in the acid.

pentine and leave it until the asphaltum is soft. Then a clean cloth may be used to wipe off the asphaltum. Afterwards, the metal should be washed with hot water and soap.

The project may be completed by being polished with number 000 steel wool. If a high polish is desired, use a buffing composition on a polishing lathe (see Fig. 8-5).

A two-tone effect can be had by leaving the etched surface unpolished. This serves as a contrasting background for the bright areas, which were protected by the asphaltum. Polish only the protected areas.

Asphaltum Varnish. Black asphaltum varnish is a good acid-resisting material because it is not affected by most acids. For this reason, it is the most commonly used material for painting the design prior to etching on metal with acid. When asphaltum is too thick for painting fine lines, it may be thinned with turpentine. There are other commercial acid-resisting materials that can be used in place of asphaltum varnish.

Hammer Marking to Decorate

the Surface of Metal

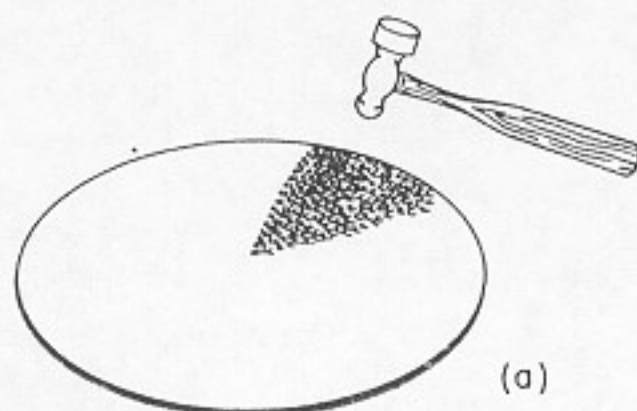
The hammer marking of metal sometimes called peening is a process of decorating the metal surfaces by making round indentations with the peen end of a ball peen hammer (see Fig. 8-12a). Long, narrow marks can be made with the peen end of a riveting hammer, as shown in Fig. 8-12b. The peen end of both hammers should

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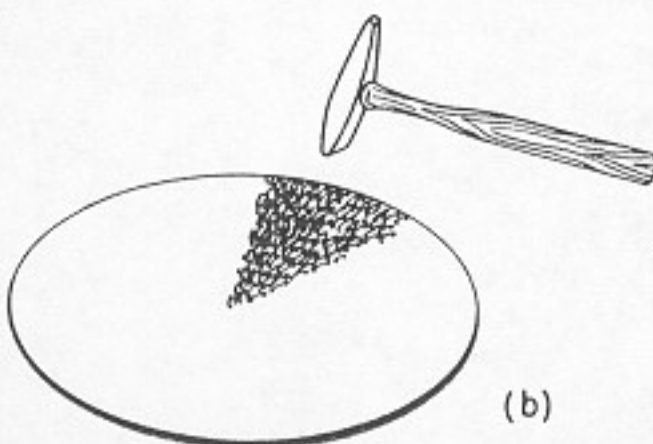
be smooth and highly polished. To hammer mark the surface of a piece of metal, place it on something solid, such as a pounding block, and strike it with light blows, using the peen end of a hammer. The hammer marks should be small and should touch one another.

Chasing Tools

Chasing tools are small tools like chisels or round end punches. Their shapes depend on the type of line or design desired. For this reason, they are made in a large variety of sizes to fit the work and the type of chasing



(a)



(b)

Fig. 8-12. In hammer marking, the metal often becomes wavy. This is caused by hitting the metal too hard.

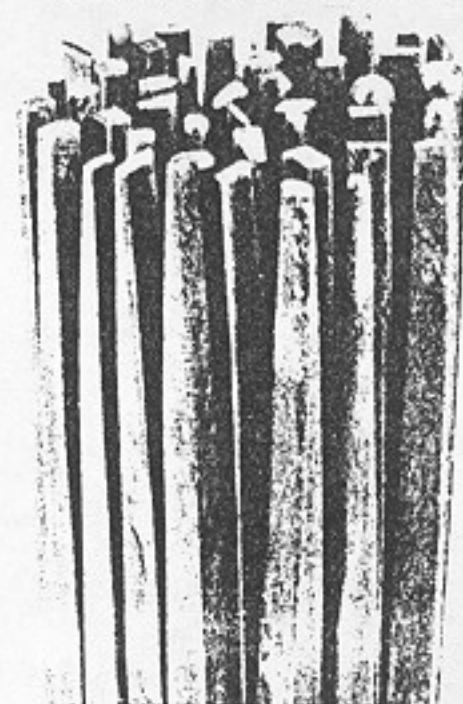


Fig. 8-13. Chasing tools are made from $\frac{1}{8}$ " to $\frac{3}{8}$ " square tool steel about $4\frac{1}{4}$ " long.

to be done. They may be purchased or made from tool steel (see Fig. 8-13). The rough shaping of the working end is done by filing or forging. The chasing end is then carefully finish filed, polished, and hardened (see "Hardening of Steel"). After hardening, the end is tempered to a light straw color (see "Tempering of Steel".) The different types of chasing tools are called tracers, punches, tools for line work, and planishers, which may be either round or flat.

Using Chasing Tools and a Hammer to Chase a Design on Metal. Chasing is the method used to raise in relief a design that has been transferred onto a surface of the metal to produce an ornamental effect. Simple chasing, such as veins in a leaf, can be done by placing the project on the end grain of a wooden block. Chasing

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of larger designs is done with the metal mounted on chasing pitch. Chasing pitch can be bought in bulk, melted, and poured into a pan one inch or more deep and slightly larger than the sheet of metal being chased. To mount the metal on this pitch, oil the back side and heat both the metal and the pitch. Then press the metal into the pitch with the oily side down. When the pitch has cooled, the metal is

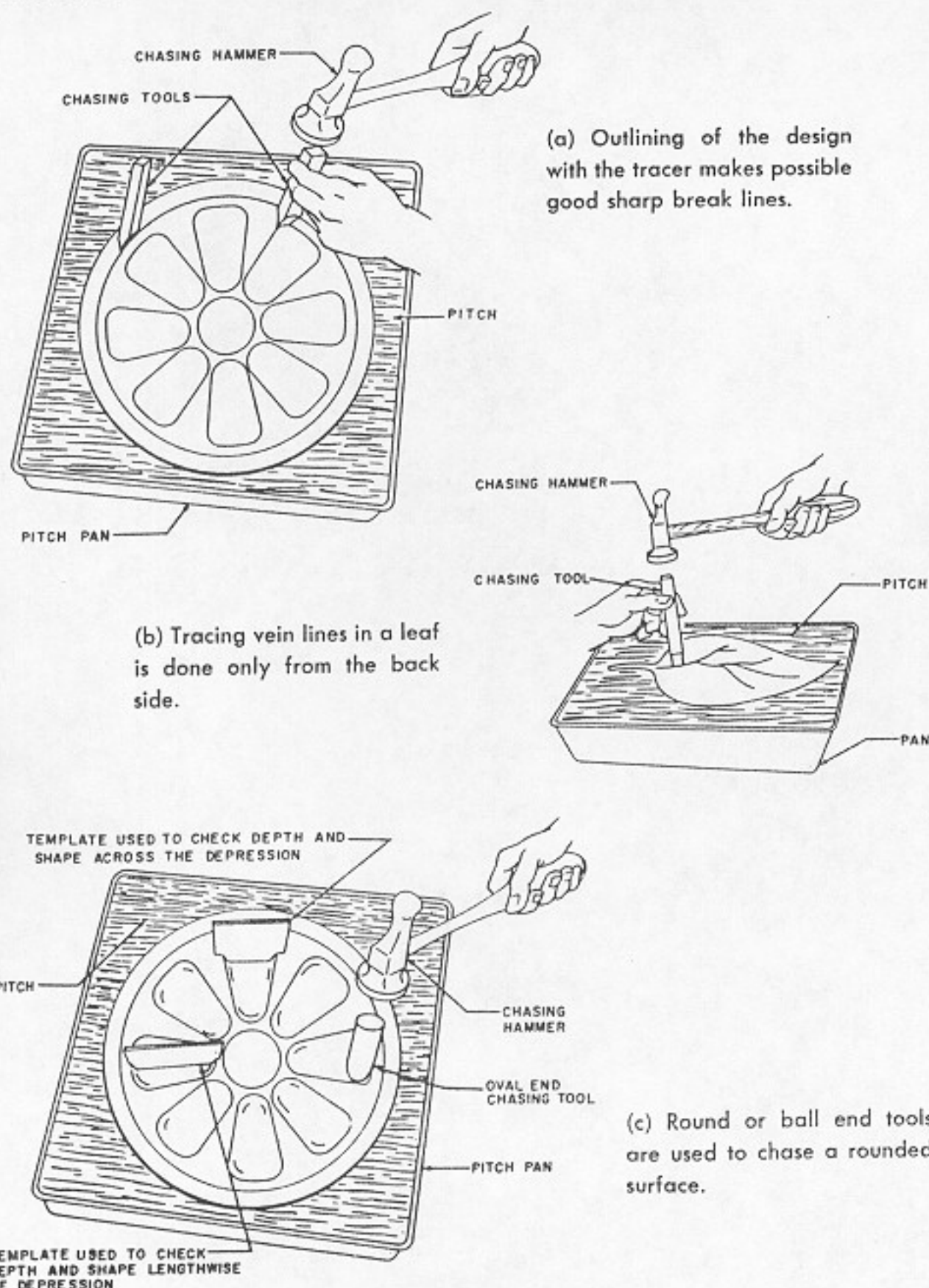


Fig. 8-14. The chasing of vein lines as shown is done only with tracing tools. The more intricate designs require an assortment of chasing tools.

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backed by the hard pitch and is ready to be worked upon.

Now select the tracing tool that will be used to outline the design (see Fig. 8-14a). Hold the tracing tool on the line so that its top is slanting slightly away from you. Tap the tool with a chasing hammer and move it toward you as shown in Fig. 8-14b. Each forward movement of the tool should overlap its previous location. When

the design has been traced, heat the metal and remove it from the pitch. Clean off the pitch and straighten out the metal. Now oil the side of the metal that has the raised outline of the design on it. Again, mount the metal on the pitch. With the round nose and oval chasing tools, work up the design within the raised outline. Remember that you are working on the back side of the design. It is often

possible to use templates when chasing, as in Fig. 8-14c. They are a great help because when you work from the back of the metal, it is sometimes difficult to visualize how the front will look. Remove the metal from the pitch, turn it over, and again mount it on the pitch. The project should now be modeled or worked on the face side until smooth.

Matting Tools

A matting tool is a type of punch that can be used to create a design on soft metals. The end of the punches can be of various sizes and shapes, such as round, square, oblong, or triangle. Further decorative effects can be produced by marking the end of the punch with dots or criss-cross lines. The over-all design on the metal is produced by repeatedly impressing this design over the entire surface to be decorated. The art metal worker usually makes his own matting tools, and soon accumulates quite an assortment.

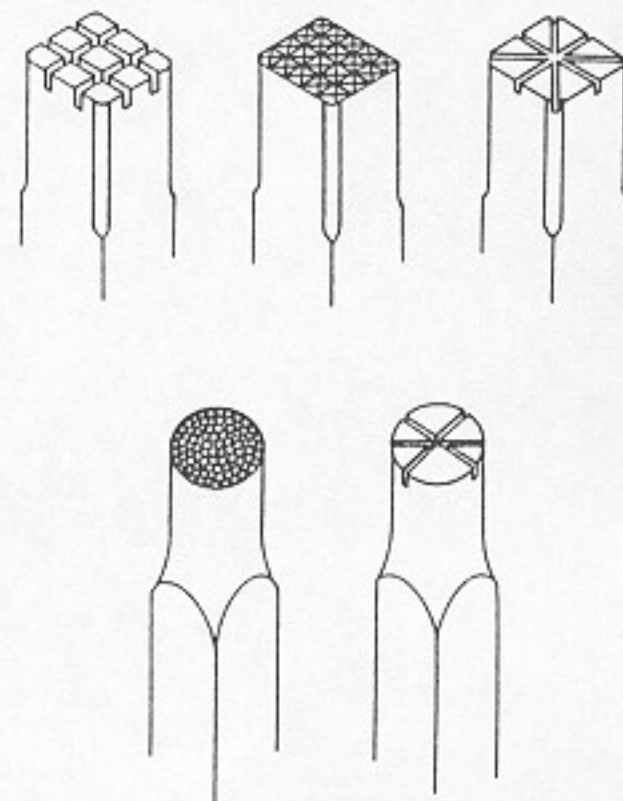


Fig. 8-15. Matting tools are generally made from $\frac{1}{4}$ " to $\frac{3}{8}$ " square pieces of tool steel about $4\frac{1}{2}$ " long.

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Using Matting Tools to Decorate a Metal Surface. To decorate a surface by matting, select a matting tool

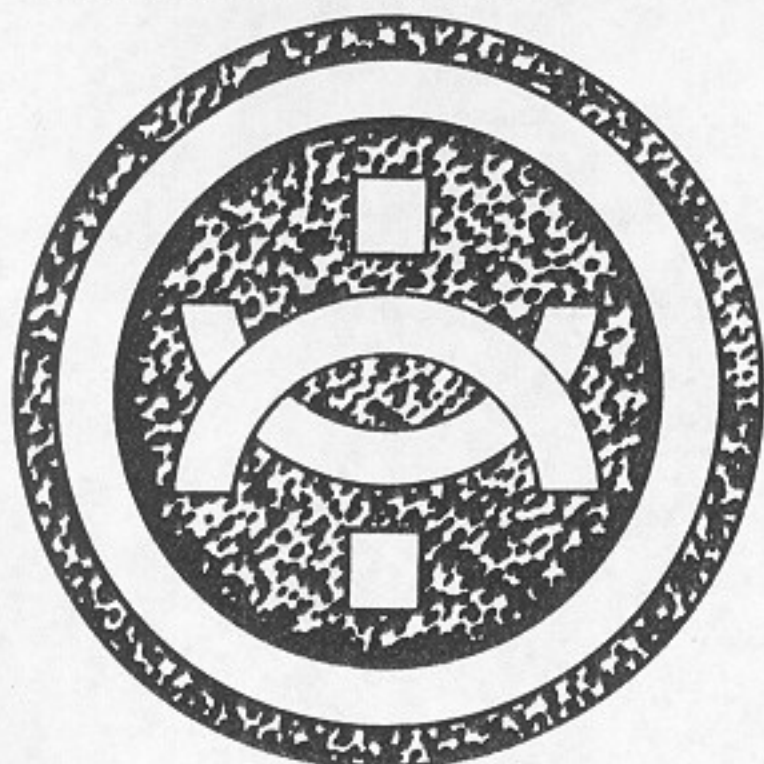
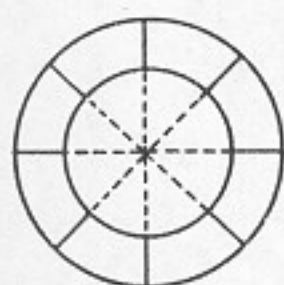
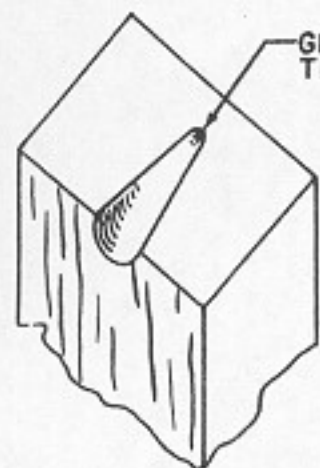


Fig. 8-16. Matting tools should always be used on soft nonferrous metal. If they are used on other metals, the design on the tool will be flattened.



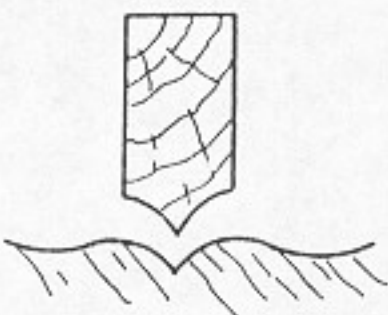
(a) Radial lines being used as locations for flutes.

(b) Hardwood stakes are used to flute both flat and curved surfaces.



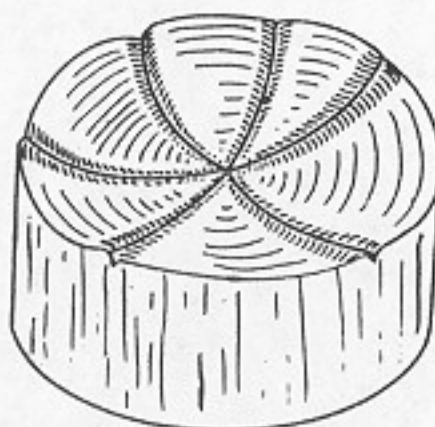
GROOVE FOR THE FLUTE

FLAT SURFACES



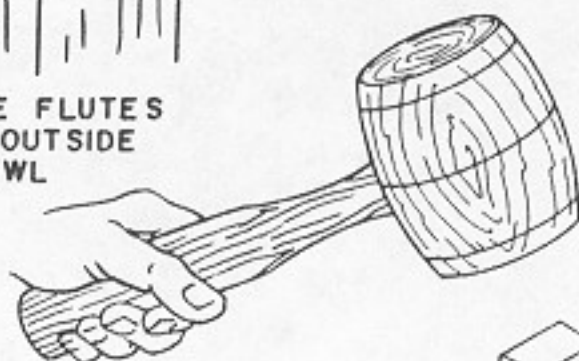
(c) The fluting tool is made to conform to the shape of the groove in the stake with which it is to be used.

(d) The groove in the wooden block should be a little larger than the flute desired, and the fluting tool should be a little smaller than the groove.



TO MAKE FLUTES ON THE INSIDE OF A BOWL

TO MAKE FLUTES ON THE OUTSIDE OF A BOWL



ASH TRAY

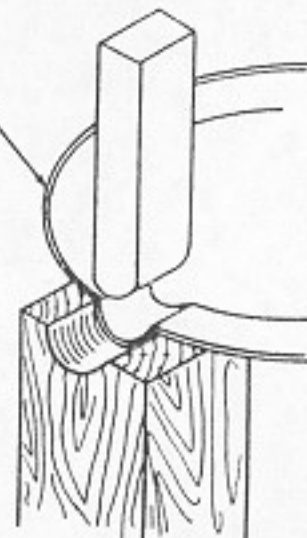


Fig. 8-17. The single-groove fluting stake is far more commonly used than the multiple-groove stake.

with the design desired for the background effect. Place the metal project on a smooth, solid metal surface. Hold the matting tool on the metal and strike it with a hammer hard enough to transfer the pattern from the end of the matting tool onto the surface of your project. After this, move the tool over so that its edge touches the mark just made. Strike the tool again. Continue until the entire background has been matted (see Fig. 8-16).

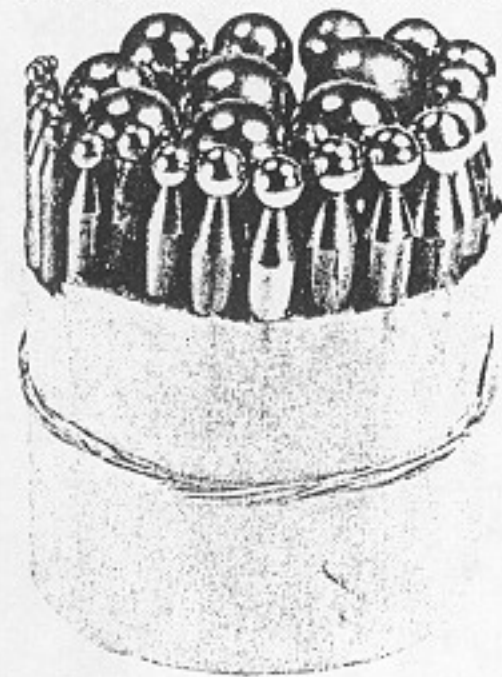
Fluting Tools

Fluting tools (see Fig. 8-17) are made from two hardwood blocks and are generally designed for specific projects. The bottom block usually has the shape of the desired flute carved in it. The top block, known as the tracer, is used to force the metal down into the depression (flute) of the bottom block.

Fluting. A flute is a concave channel made in metal trays and bowls to decorate them. It is created over a hardwood stake with the aid of a hardwood or metal fluting tool. The flutes are usually made on lines that radiate from the center of the object to its outside edge (see Fig. 8-17a).

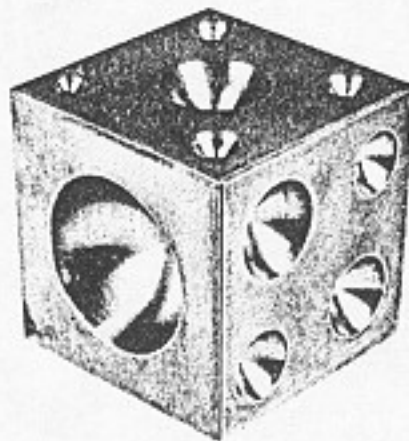
The hardwood stakes are made by shaping them to fit the contour of the object to be fluted (see 3-16b and c). The groove for the flute is carved into the end of one of the stakes and the end of the fluting tool is made to conform to this groove (see Fig. 8-17c and d).

When the two wooden tools have been made, you are ready to make the flutes. Place the metal on the hardwood stake with the selected location for a flute directly over the groove. Now place the fluting tool on the metal, directly over the groove, and force the metal down and into the groove by hitting the fluting tool with a hammer or mallet (see Fig. 8-17d). This will seldom form the complete flute. It may be necessary to move the tool several times before a single

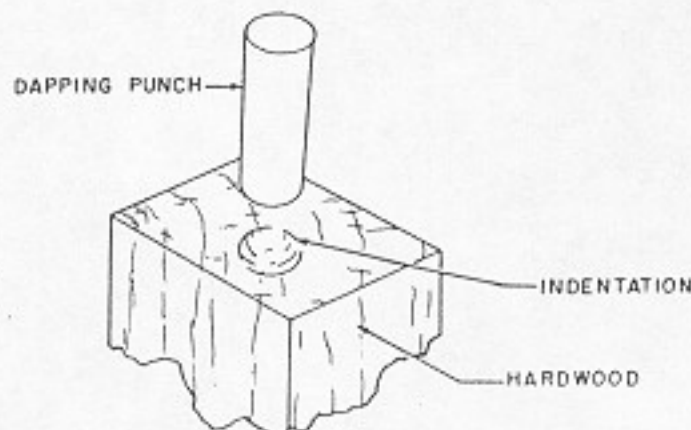


(a) Dapping punches.

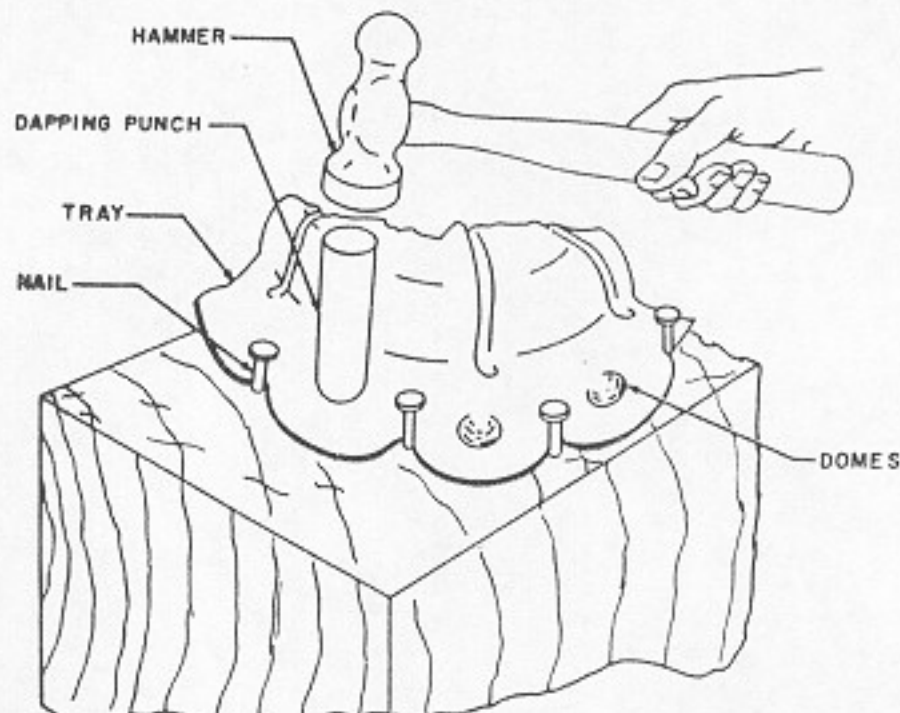
Fig. 8-18. Domes are raised from the back side of the metal. This makes a rounded dome on the front side, which often adds to the appearance of the design.



(b) Dapping die.



(c) The indentation is made in the wood with the punch.



(d) Use nails as guides whenever possible.

metals.

Using the Dapping Punch and Die to Decorate a Metal Surface. The raising of domes is done by first laying out the locations for the domes. These points are then placed directly over the indentation in the block. The dome is raised by hitting the punch with several light blows of the hammer. It is possible to use nails to fix the location for domes if notches are part of the edge design as shown in Fig. 8-18d.

Metal Finishing

Metal finishing is the process of beautifying the surface of a metal object. This can be done in many ways. Good results can be attained with chemical or by applying heat and oil.

Chemical Finishes. There are a great number of chemical processes for finishing metal. Some of them are very complex and require a great deal of equipment. However, there are a few relatively simple and easy methods that can be used in a school shop.

Shades of Brown to Black on Copper. Copper seems to lend itself to chemical finishing better than brass or aluminum. Liver of sulphur (potassium sulphate) will produce shades of brown to black on copper. To prepare the solution, dissolve a small piece about the size of the end of your thumb in about a pint of water. Dip or suspend the article to be colored in this solution. After half a minute to a minute, remove the article from the solution. If the color is the shade desired, let it dry; do not wipe the metal with a cloth. For a darker shade, dip it a second time. When dry, polish it with fine steel wool. Shading can be done by polishing more in some places than in others.

Using Heat and Oil to Color the Surface of Black Iron or Wrought Iron. When heat is applied to steel, the metal will change from a light straw color to a dark purple as it becomes hotter. These colors cannot be seen unless the metal has been polished. When using this method to color

flute is fully formed. Shift the metal for the next flute and continue this process until all the flutes have been made.

Dapping Punch and Dapping Die

Dapping tools are used to decorate

the surfaces of metal. The dapping punch (see Fig. 8-18a), when used with the dapping die (see Fig. 8-18b) or a depression in a wooden block (see Fig. 8-18c), will form domes or, as they are sometimes called, beads on the surface of nonferrous or precious

metal, the heat should be applied with an open flame, such as is produced with a Bunsen burner or a welding torch. As the metal becomes hot, move

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the flame or the metal so that the entire surface that you wish to color will turn the same color at the same time. When the desired color appears, cool the metal in clear, cold water and let it dry. Do not wipe it with a cloth.

Questions

1. Is all steel wool alike? If not, explain the difference.
2. Why is it necessary to apply a protective coating to copper and brass?
3. What is the acid used to etch copper? Is it used at full strength?
4. Asphaltum varnish is used for what purpose when you are etching?
5. What are two reasons why black streaks of buffing composition may form on the metal surface while buffing?
6. What is the difference between greaseless and double-duty buffing composition?
7. Explain when to use a sewed buffing wheel and when to use a loose buffing wheel.
8. What is meant by the word "coloring"?
9. Is it practical to use a greaseless compound on a buffing wheel that has had a double-duty or chrome composition on it?

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C H A P T E R

9

Metal Spinning

This chapter covers the following subjects:

Metal Spinning Lathe, 105 • Spinning Tools, 106 • Chucks for Metal Spinning, 108 • Metals Adaptable to Spinning, 109 • Spinning Metal, 110 • Polishing Metal That Has Been Spun, 117 • Rolling a Bead, 118

Metal spinning is a fascinating art. As we have learned, metals can be formed into various shapes by bending, by forging, by molding, and by machining with cutting tools. Spinning is another way of shaping metal. Spinning is accomplished by revolving a sheet metal disc in a lathe and pressing a hand tool against the disc. The sheet metal disc takes the form and shape of the wooden chuck (see Fig. 9-1) against which it is being pressed.

Metal Spinning Lathe

The colored surface should then be protected with clear lacquer or wax.

Another method of finishing that can be applied to iron or steel is to scorch oil onto the surface. To do this, heat the metal until it will scorch the oil. The oil can be applied with a saturated rag. Linseed oil will give a brown color, whereas machine oil will produce a black color.

essential parts of the tool rest are the fulcrum pins (see Fig. 9-3b). In use, the spinning tool is placed on top of the tool rest and is held against one of the fulcrum pins. Two fulcrum pins are generally placed in readiness in the tool rest, one for the spinning tool and one for the backstick.

In metal spinning at a lathe, a special type of *tailstock live center* (see Fig. 9-4) is used. It is constructed in such a way that the point revolves on ball or roller bearings. These bearings are necessary because a very heavy pressure is exerted against this live center during the spinning process.

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Spinning Tools

The six hand tools shown in Fig. 9-5 are needed to do simple metal spinning. These tools can be purchased, although many good metal spinning craftsmen like to forge their own tools from $\frac{3}{8}$ " or $\frac{1}{4}$ " drill rod. Note carefully the shape of each tool. These

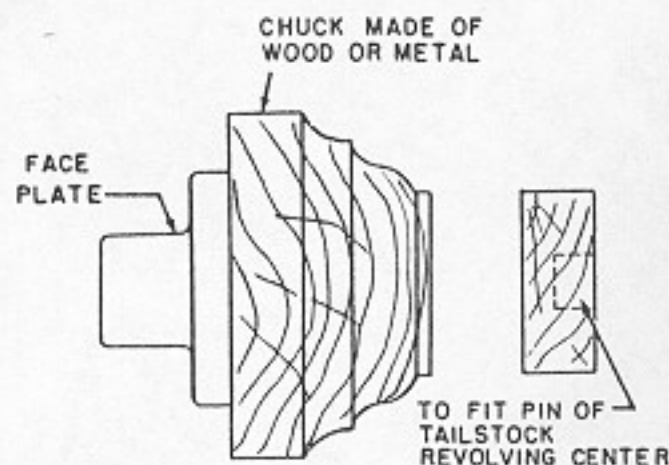


Fig. 9-1. Metal spinning chucks that are going to be used repeatedly are often made of metal, or of wood with a metal shell spun over the wood and fastened to the chuck.

A metal spinning lathe (see Fig. 9-2) should be solidly built, because it usually is run at fairly high speeds, ranging from 600 to 1,800 revolutions per minute. The headstock is equipped with end thrust bearings capable of withstanding heavy thrusts for long periods of time. Although an ordinary lathe can be used for metal spinning, the bearings are seldom built heavy enough to withstand the strain placed upon them.

The *metal spinning tool rest* (see Fig. 9-3a) is a very important part of the lathe for metal spinning. Two es-

shaped ends must be carefully formed, hardened, and polished to a glass-like finish. Each tool serves a special purpose in forming the metal. The handles are large to make it possible to hold the tool between the arm and the body. Sections from old baseball bats make suitable handles for these tools.

The end of the *round nose spinning tool* (see Fig. 9-5a) is shaped like the

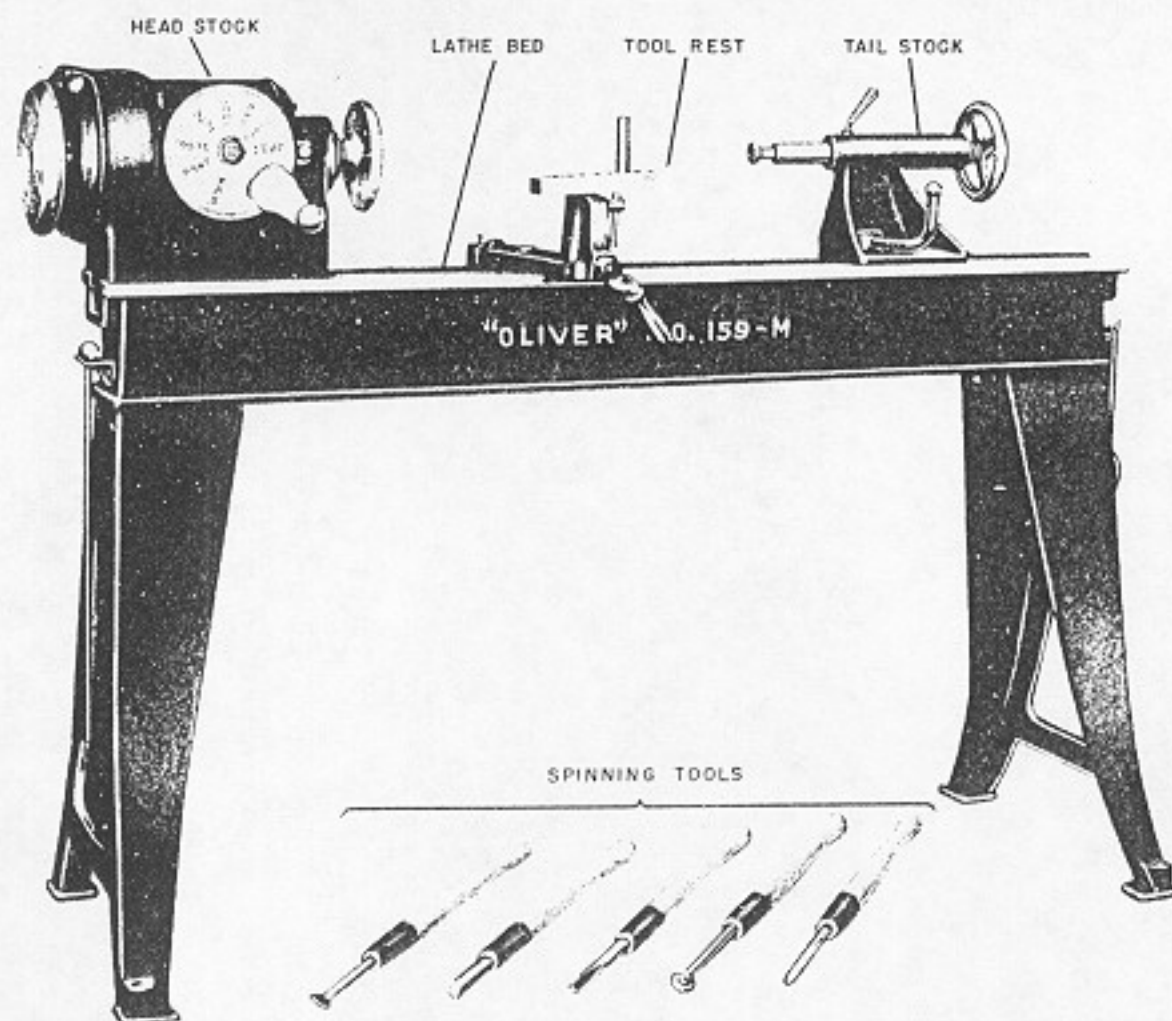
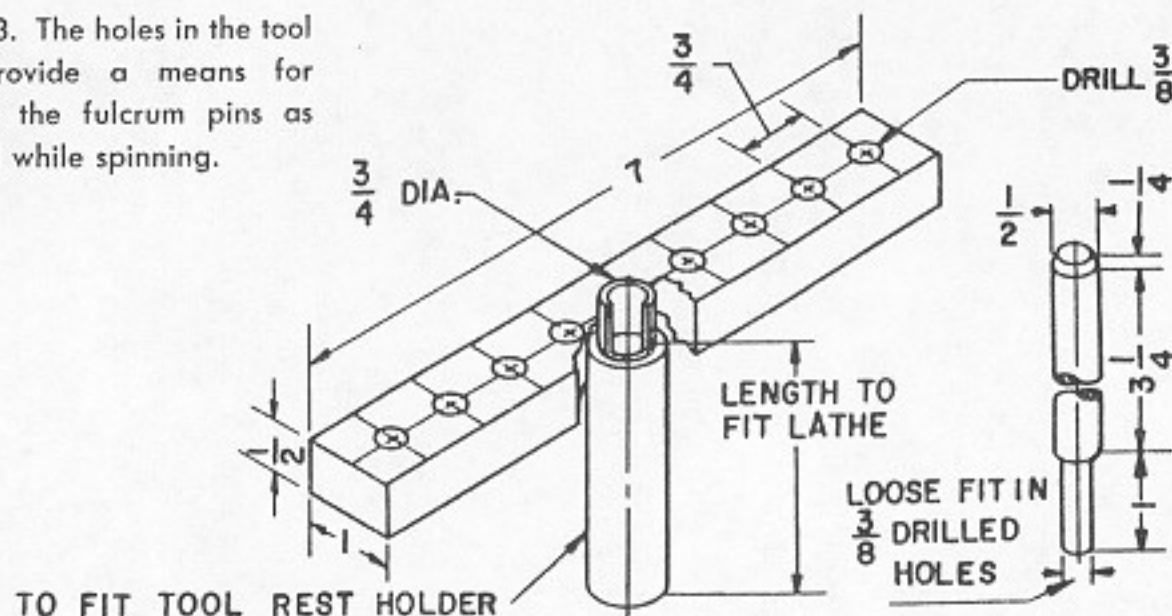


Fig. 9-2. Metal Spinning Lathe. (Courtesy Oliver Machinery Co.)

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Fig. 9-3. The holes in the tool rest provide a means for moving the fulcrum pins as needed while spinning.



nose of a rifle cartridge. It is used for the spinning of small pieces and for the final shaping into corners and small grooves.

The *tongue tool* (see Fig. 9-5b) may be the first tool used in starting the actual spinning operations. It is used for forming the metal against the chuck and is sometimes used for smoothing out the tool marks that may have been made while spinning.

The *ball tool* (see Fig. 9-5c) is used to spin the metal into radius depressions and portions of the

chuck.

The *trimming tool* (see Fig. 9-5d) is used to trim the disc to size before you start spinning. Two styles of trimming tools are used, the diamond point and the round nose. Although the diamond point is the more widely used, the round nose is often used by some spinners.

The *beading tool* (see Fig. 9-5e) is used to roll beads on the edge of spun articles. The groove in each beading roll, of which there may be several, is made to the size of the bead to be

rolled.

The *backstick* (see Fig. 9-5f) is used to support the back side of the metal being spun. It is about one inch in diameter and fourteen inches long. One end of it is planed to a flat wedge. Old broom handles make good backsticks.

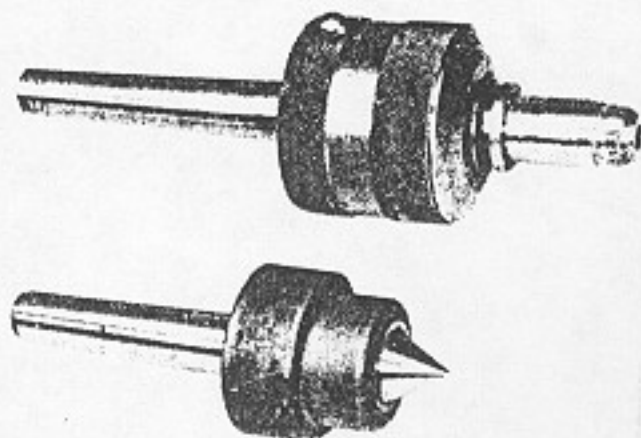


Fig. 9-4. A tailstock live center is used in metal spinning, as it is the pressure against this center that holds the metal against the chuck during the process of spinning.

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Chucks for Metal Spinning

Chucks for spinning metal are usually made of solid blocks of wood. The metal is forced to take the form of the wood chuck. Chucks are generally made of maple or birch. They are fastened to the face plate of a lathe and then turned to the exact size and shape of the finished article.

Chucks for spinning metal are of two types, the solid and the collapsible (or sectional). The *solid*, sometimes called a one-piece, chuck (see Fig. 9-1a) is the more commonly used. It is, also, the easiest chuck to make and the one on which you will do almost all your spinning. However, as you become skilled in spinning, you may want to make a project that is shaped, let's say, like a bowling pin. Now, when you spin the metal around this shape of chuck, you would ordinarily be unable to remove the metal from the chuck. However, if the chuck were made of pieces or sections, you could remove a piece of the chuck at a time. This is the principle of the *sectional chuck* (see Fig. 9-6). Another type of chuck that may

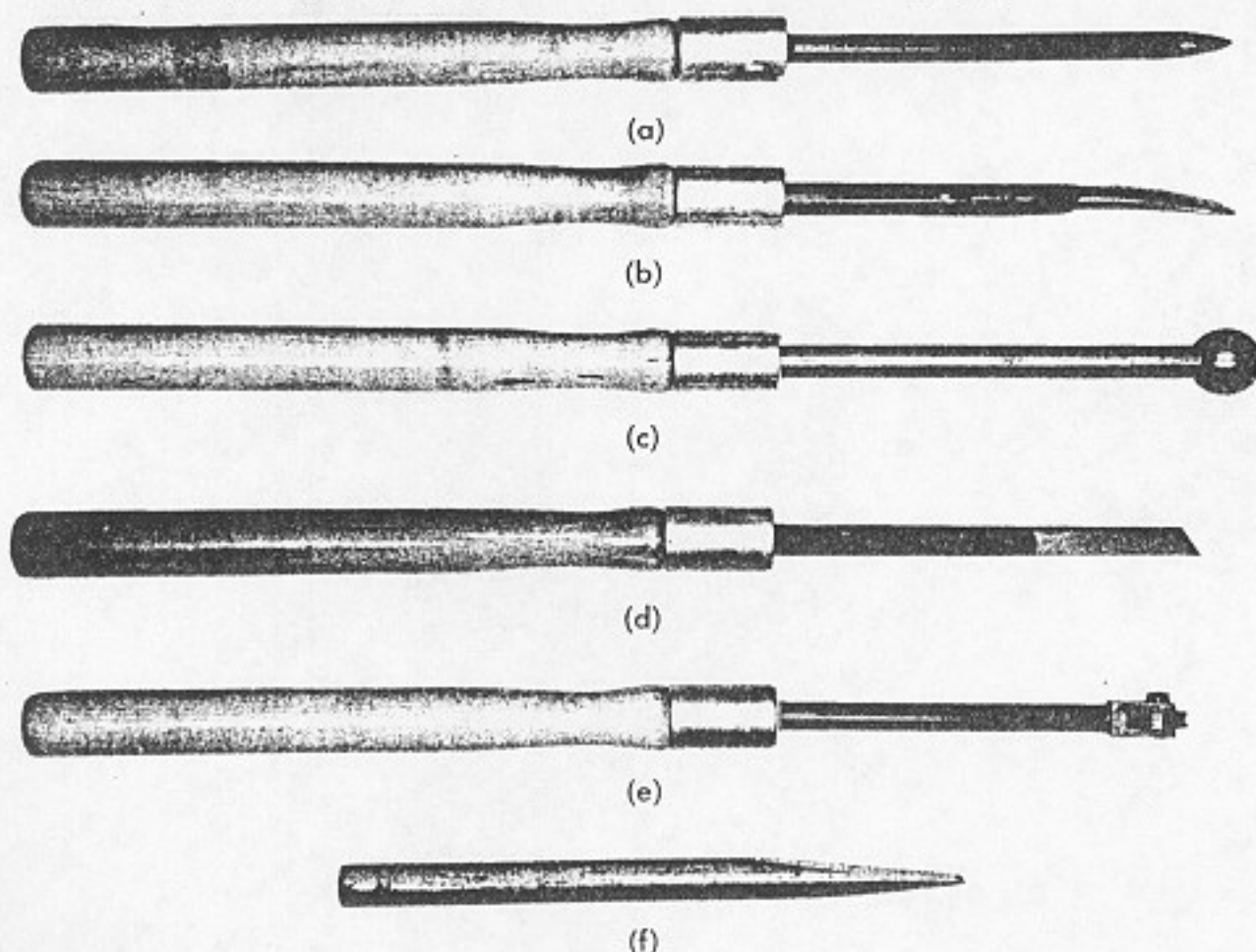


Fig. 9-5. Metal Spinning Tools.

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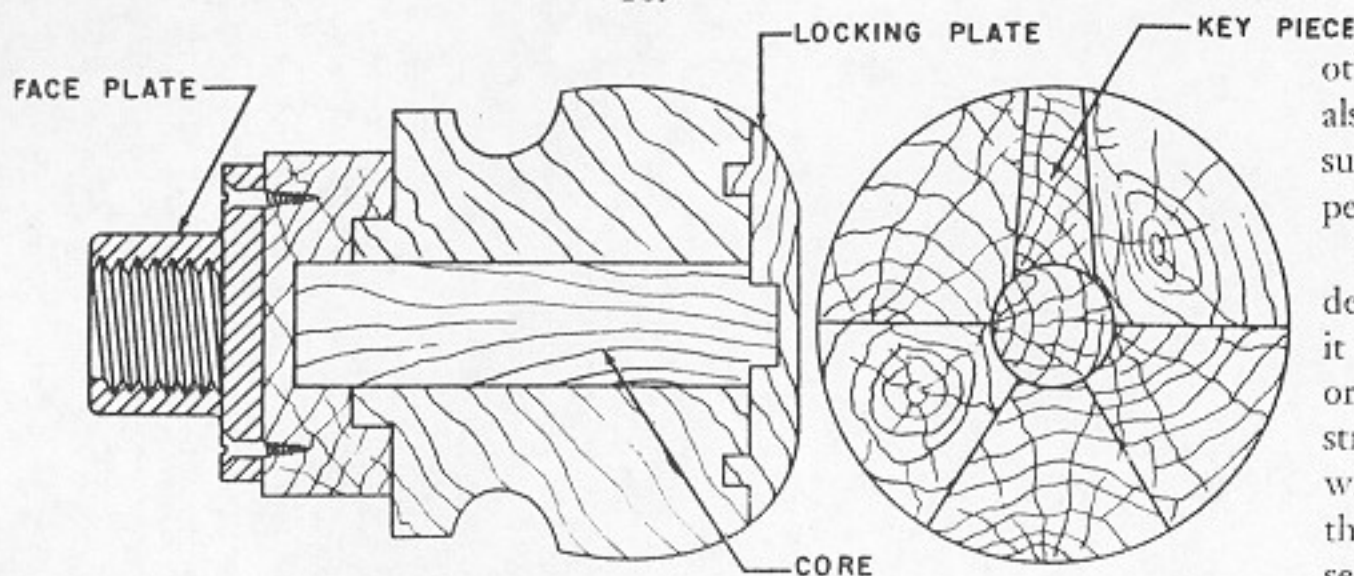


Fig. 9-6. The sectional chuck can be collapsed by removing the locking plate and pulling out the core. The key section can then be removed and the other sections are free.

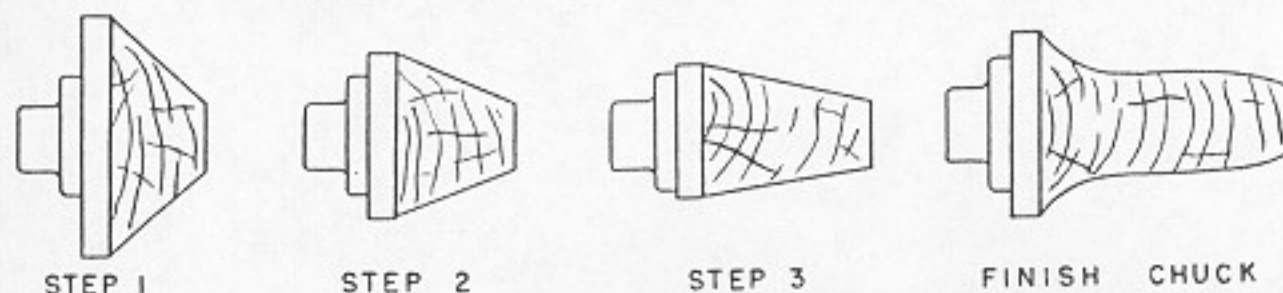


Fig. 9-7. Breakdown chucks are used in spinning deep objects.

be used is called a *breakdown chuck* (see Fig. 9-7). This chuck is used only to spin the metal down step by step by  by  to the finished shape , such as in the making of a straight-sided cylinder, for example, a drinking glass or a vase. Some means must be provided for

holding the metal to the chuck during the spinning. This is done with a *follow block* (see Fig. 9-1b), which is a piece of wood turned on the lathe to the same size as the base of each chuck, or slightly smaller. The work side of the follow block is perfectly flat and the other side is bored to fit the point of the spinning center. In use, the metal is held between the base of the chuck and the follow block by pressure from the tailstock and the spinning center.

Metals Adaptable to Spinning

Virtually any sheet metal can be spun, provided that the person doing the spinning is highly skilled and possesses the proper equipment. However, certain metals lend themselves more readily to the process of spinning than

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others. They are the nonferrous metals (that is, those containing no iron), such as aluminum, copper, brass, and pewter.

Each of these metals possesses a high degree of ductility, which means that it can be drawn out, hammered thin, or easily formed without being stretched beyond the point where it will break. However, in working, these metals become hard. As we have seen, this is known as work hardening. To overcome this hardness, they are annealed or made soft again by heating and then cooling rapidly. (See "Annealing of Nonferrous Metals.") After proper annealing, the metal should again be as soft as when you first started to work on it.

All these metals are soft and scratch easily. The careless handling of the metal can only make extra work for you, since all the scratches must be removed before a good polishing job can be obtained.

Spinning Metal

First, the chuck must be turned to

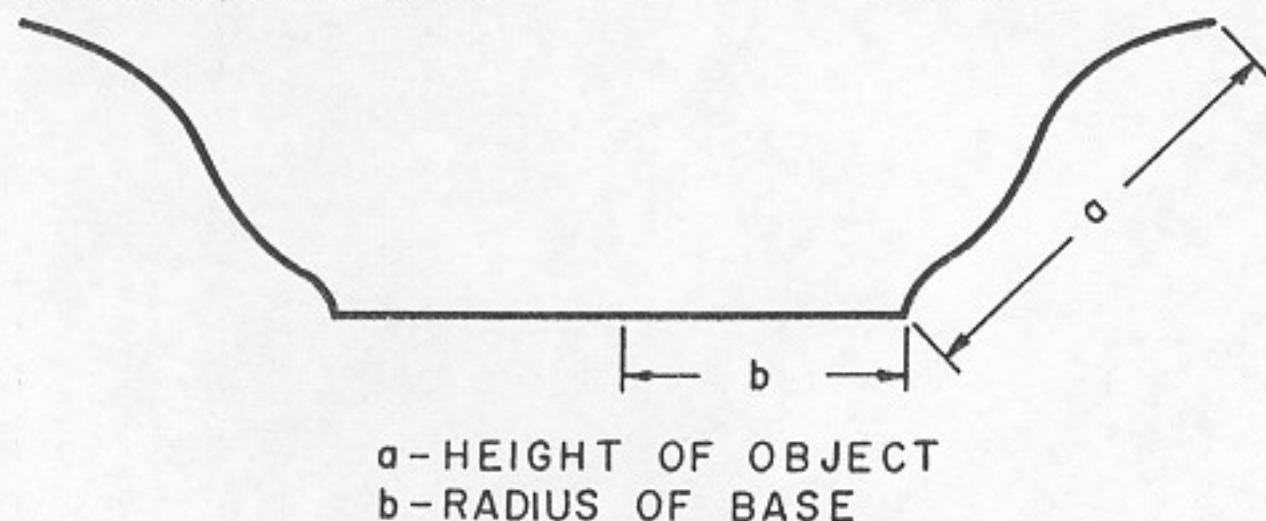


Fig. 9-8. No set rule can be applied to determine the size of disc to be used. With practice and experience you soon learn how large a disc is required.

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the same size and shape that the finished project is to be. A chuck can be made for each individual job, or may be used for spinning any number of like pieces.

Determining Size of the Disc to Be Used. To determine the size of the metal disc to be cut for use with a chuck, a rule-of-thumb method is generally used (see Fig. 9-8): Measure the height of the object or the chuck from the base to the rim, a , and add this amount to the radius of the base, b . When this rule is followed, the disc is usually slightly larger than needed. Practice at spinning will soon show about how much to reduce the disc size to avoid using too large a piece of metal. CAUTION: ALWAYS REMOVE ALL

SHARP EDGES AND BURRS FROM THE EDGE OF THE METAL DISC WITH A FILE BEFORE STARTING TO SPIN.

Spinning Metal. Place the disc of metal between the chuck and the follow block (see Fig. 9-9a). Then center the disc as closely as possible by sight. Now with the hand wheel of the tailstock, tighten the follow block against the metal disc. Another method of centering the disc is to adjust the tool rest parallel to the bed of the lathe and about one and one-half inches away from the edge of the metal. Start the lathe and place the backstick between the edge of the disc and the tool rest as in Fig. 9-9b. After doing this, carefully and very slowly

loosen the handwheel of the tailstock spindle while at the same time pressing the backstick against the revolving metal disc. Watch the disc carefully and you will find that the pressure from the backstick will cause it to center itself. Now quickly tighten the

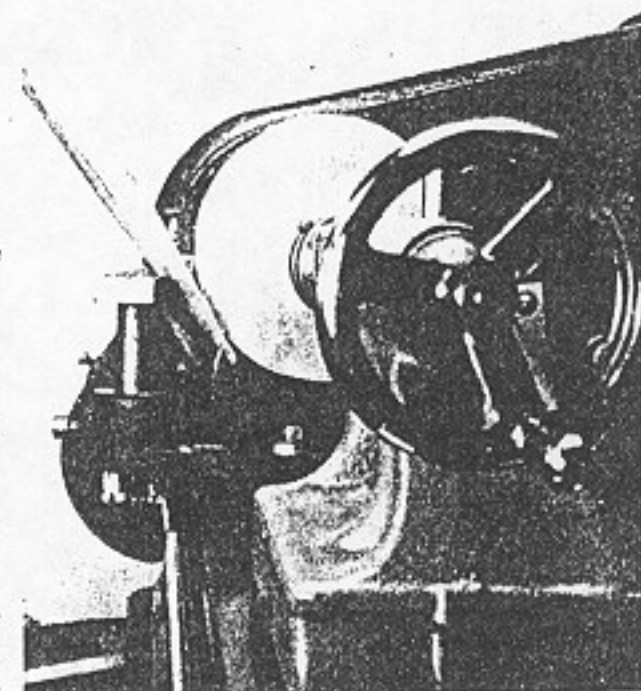


Fig. 9-9b. The disc may be centered with the back stick. However, it is safer to center it as closely as possible by sight and then trim the disc.

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follow block against the metal. The first method is considered the safer of the two.

Once the metal has been centered, it must be hooked onto the base of a spinning chuck. To do this, move the tool rest back about two to three inches from the edge of the disc. Start the lathe and apply a lubricant to the outer surface of the metal (see Fig. 9-9c). This should be done carefully; when too much lubricant is used, it may be thrown off the metal disc through centrifugal force and be splattered about. Several kinds of lubricants may be used; however, for school use on copper, aluminum, or brass ordinary brown laundry soap or candle stick has proved very satisfactory. While applying the lubricant and during the process of spinning, care must be taken so that neither the hand nor the fingers will come in contact with the edge of the revolving disc.

Insert the fulcrum pin in the tool

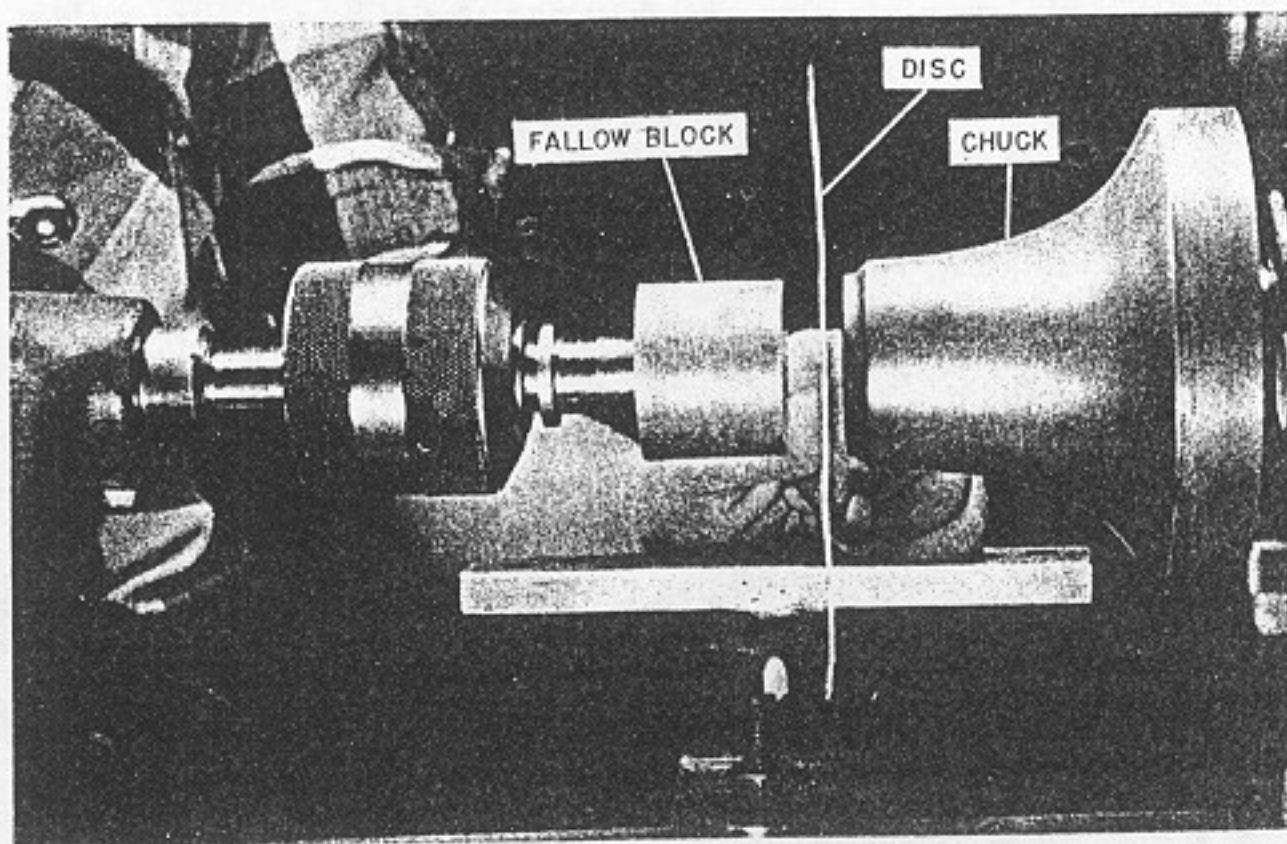


Fig. 9-9a. The disc is placed between the chuck and the follow block.

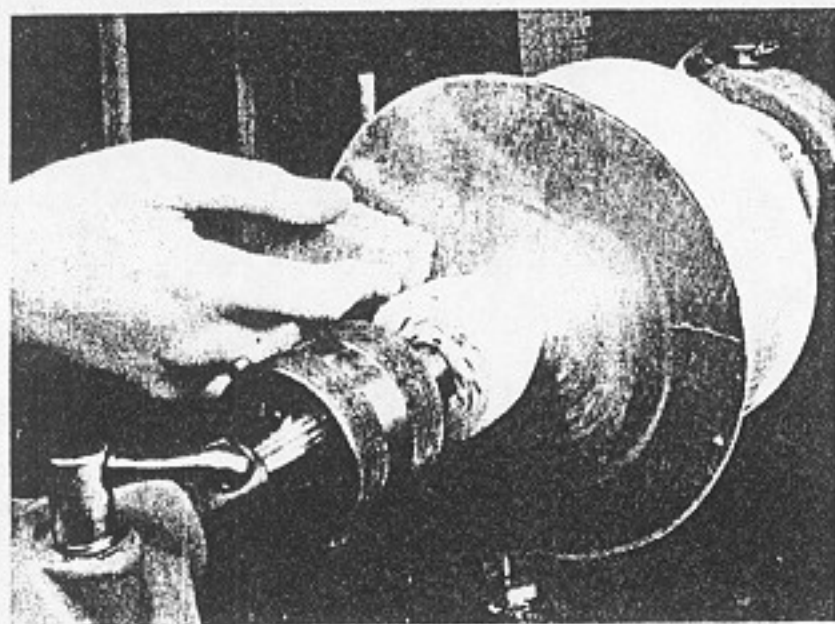


Fig. 9-9c. The disc must be lubricated before spinning.

When the disc is smooth and running without wobbling, turn off the lathe and move the tool rest up to within about one-fourth of an inch from the disc. Start the lathe, with a trimming tool held firmly on the tool rest; carefully trim the edge of the metal until a cut is taken all the way around the outside edge of the disc (see Fig. 9-9f). During the process of trimming, small burrs are made at both

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sides of the trimmed edge. They are easily removed while the disc is re-

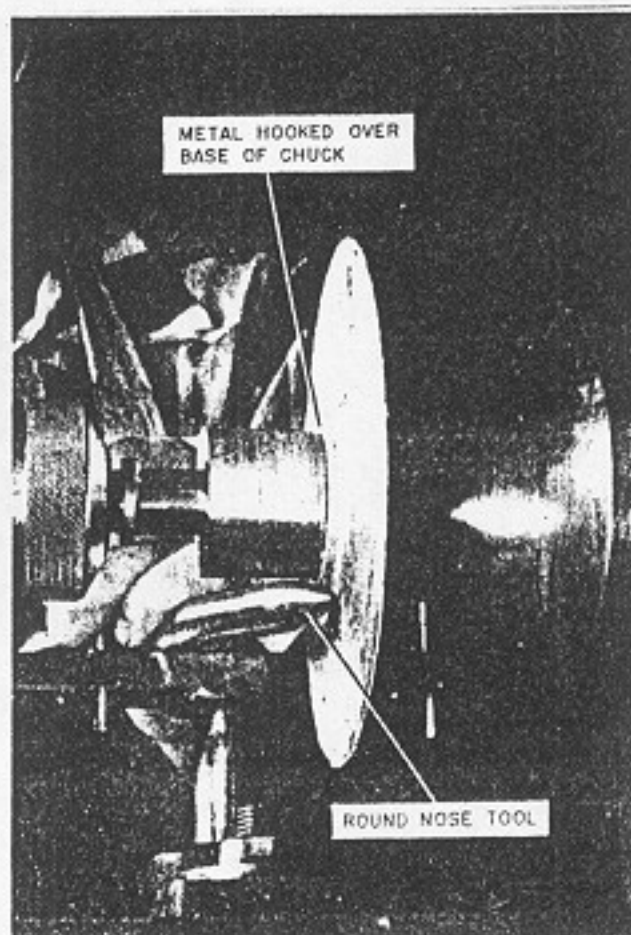


Fig. 9-9d. The metal should be hooked to the chuck as soon after being centered as possible, as the hooking of the metal makes it impossible for the disc to move off center.

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rest; it should be about one to two inches back from the outer surface of the disc. Then set the speed of the lathe between 1,000 and 1,400 revolutions per minute. Carefully study Fig. 9-9d, which shows the correct method of holding a spinning tool and its position on the tool rest when hooking the metal. Using the round nose tool, and with body pressure, move the handle of the tool to the right. The pressure of the spinning tool shapes the metal over the edge of the chuck, hooking

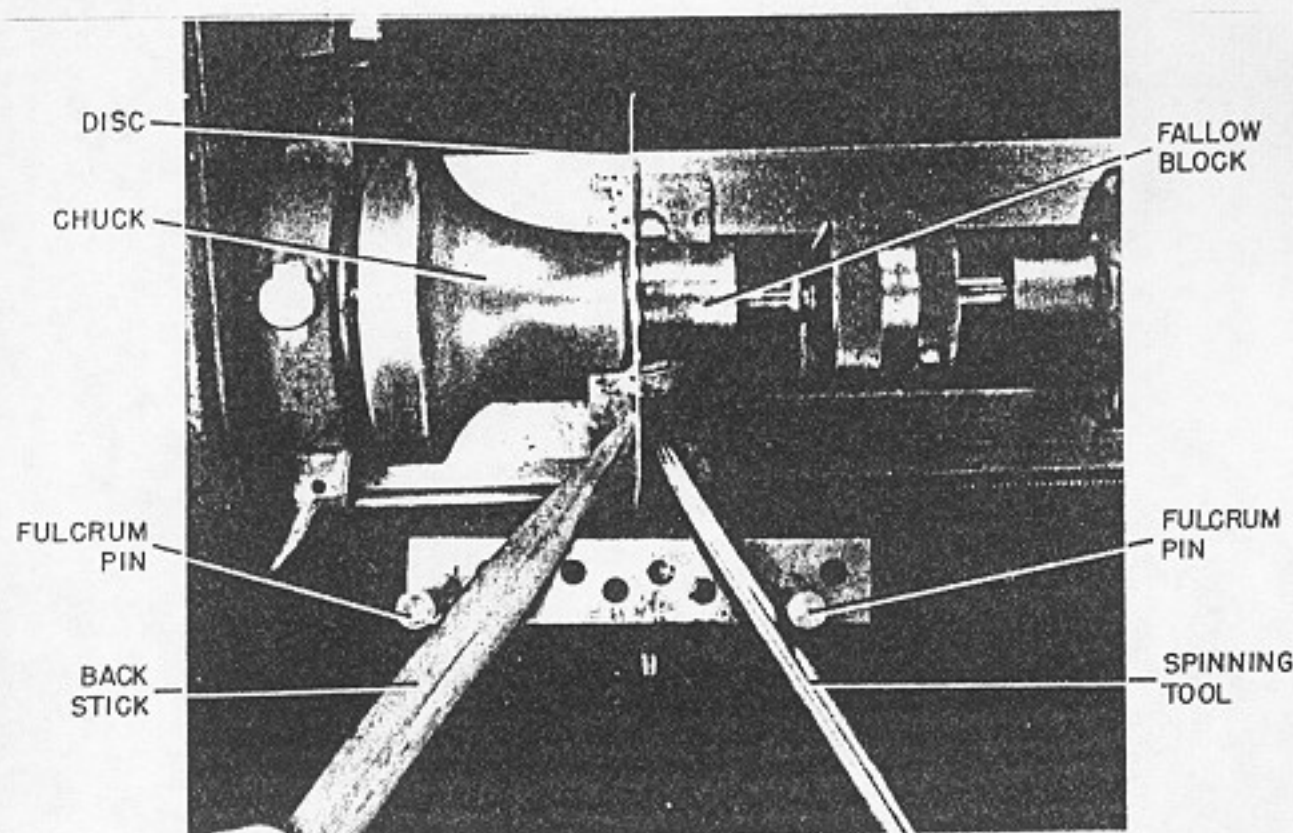


Fig. 9-9e. When it is not possible to smooth out the waves and wrinkles with the back stick, remove the metal from the chuck and use a mallet and stake.

the disc to the base of the chuck (see Fig. 9-9d). A number of short up and down strokes will form from one-fourth to one-half inch of metal to the chuck. This process may cause waves or wrinkles to form in the metal.

To remove these waves, both the backstick and the spinning tool are used. Insert a second fulcrum pin to the left of the metal. Hold the backstick against the left side of the metal and the spinning tool against the right side (see Fig. 9-9e). While exerting equal pressure on both tools, move them slowly toward the outer rim of the metal. Repeat if necessary to smooth out the wrinkles.

volving by holding a coarse double cut file against each edge as in Fig. 9-9g.

After the edge has been trimmed, stop the lathe and move the tool rest back from the disc approximately two or three inches. Insert both the fulcrum pins in the tool rest. Start the lathe again and lubricate the metal. You are now ready for the final forming of your project onto the chuck. To do this, hold the tongue tool on the tool rest the same as when you hooked the metal onto the base of the chuck. Starting at the base of the chuck, move the handle of the tool to the right and upward as shown in Fig.

9-9h. Work the spinning tool so that the metal is gradually formed toward the chuck. If the metal waves or wrinkles, support it with the backstick. This is done with the tool and backstick moving from the center out to the edge as the metal is formed toward the chuck. Your next step is to lay the metal onto the chuck with a reverse operation of the tool (see Fig. 9-9i), that is, working from the outer edge down to the center. Metal spinners use a combination of these two tool movements from the center toward the outer edge and from the

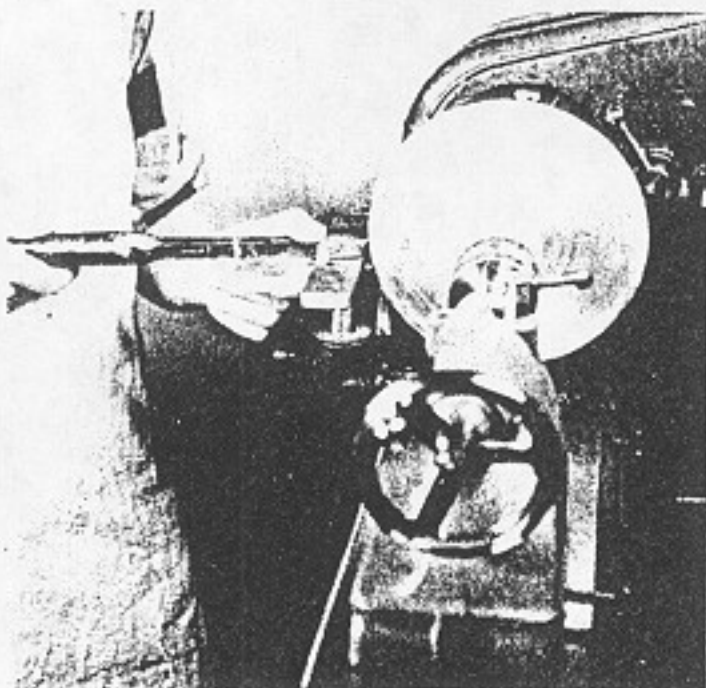


Fig. 9-9f. The edge of the disc is trimmed until it runs true.

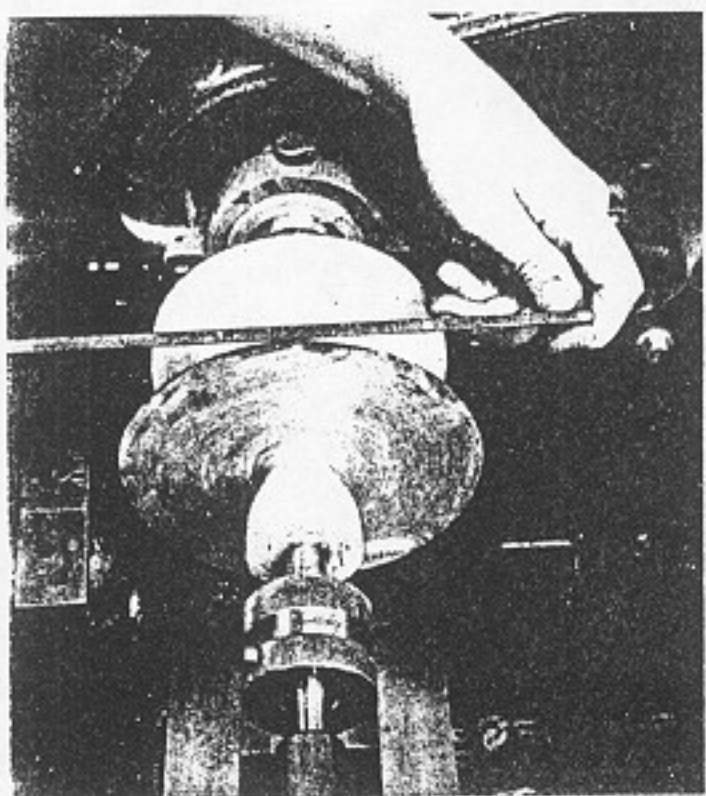


Fig. 9-9g. A coarse file removes the burrs made in trimming of the disc.

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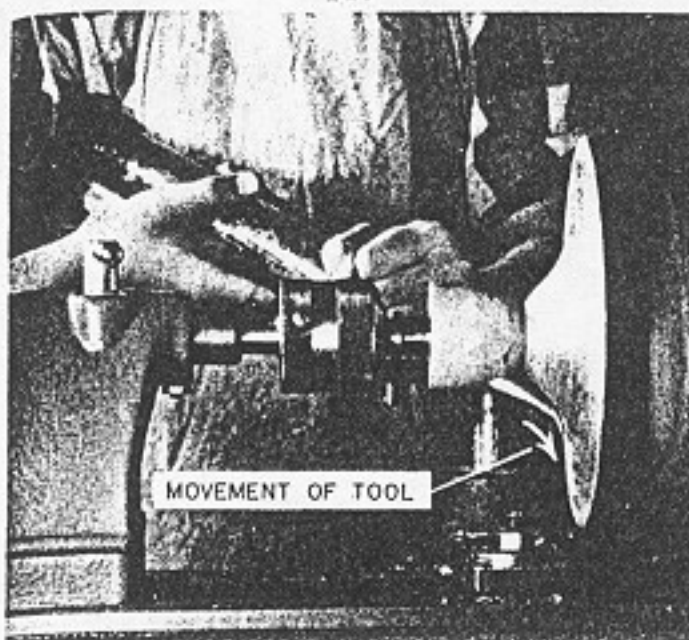


Fig. 9-9h. The spinner applies pressure on the metal with a long-handled blunt tool. Note the movement of the tool as indicated by the arrow.

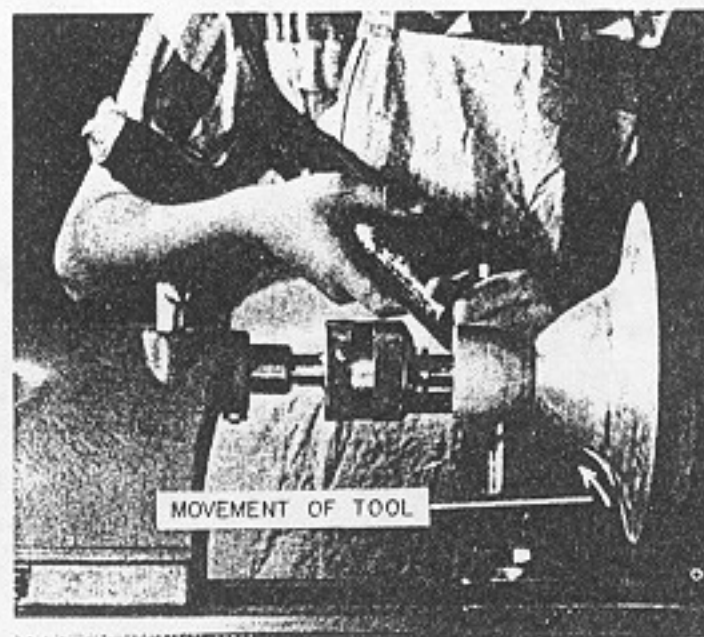


Fig. 9-9i. The spinning tool is guided with the hands, arms, and body. The pressure of the tool against the metal causes it to form or flow snugly over the chuck. Note the movement of the tool as indicated by the arrow.

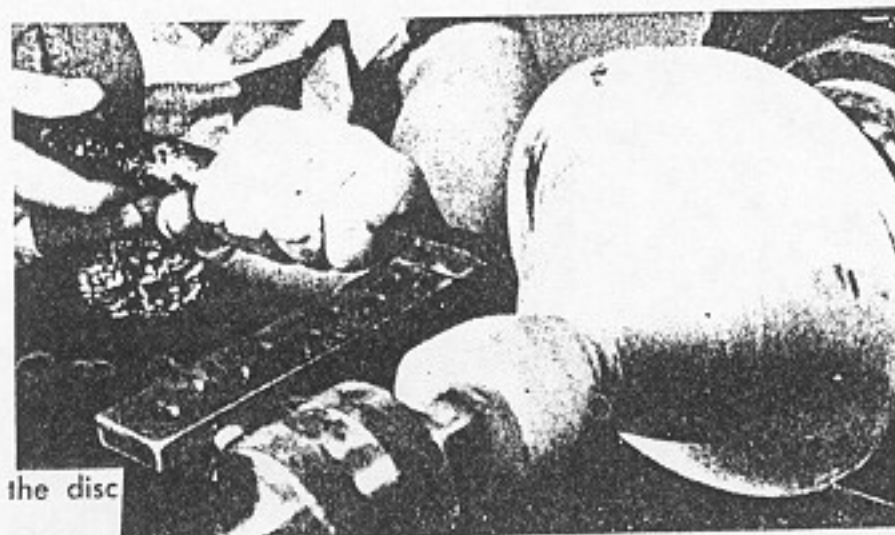


Fig. 9-9j. Trimming the disc to the finished size.

outer edge toward the center as the metal is spun. The outward movement stretches and thins the metal. The inward movement pushes the metal back toward the center or compresses it. The use of these two tool movements helps in maintaining the original metal thickness. Continue spinning until all but about one-fourth of an inch of the metal is laid onto the chuck. You are now ready to trim the disc as in Fig. 9-9j to the finished

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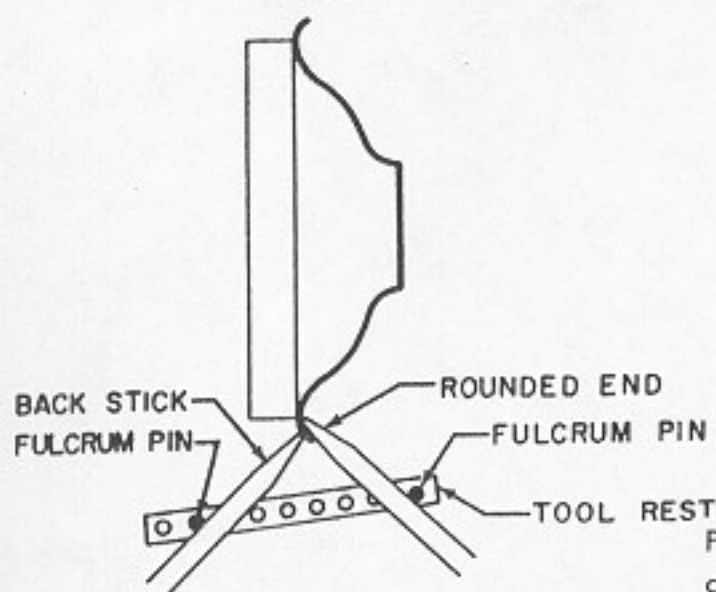


Fig. 9-9k. Applying pressure with the back stick to start the bead.

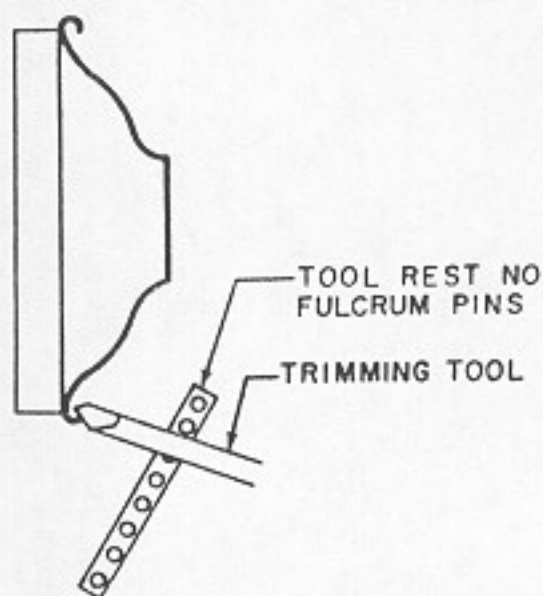


Fig. 9-9m. If it appears that too much metal is being rolled to form the bead, trim off the surplus metal.

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Polishing Metal That Has Been Spun

Whenever you polish a spun object, the tool rest should be removed from the lathe. Then remove the lubricant from the project. The final pol-

ishing of copper, brass, or aluminum may be done with number 000 steel wool or 320 grit aluminum oxide cloth. This is followed with double duty buffing composition that has been applied to a paper towel. Hold the paper towel and composition against

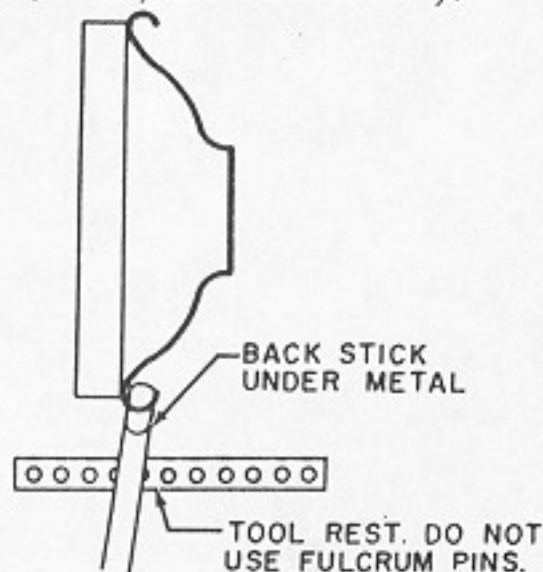


Fig. 9-9l. Applying pressure upward while at the same time turning or rolling the back stick to roll the bead.

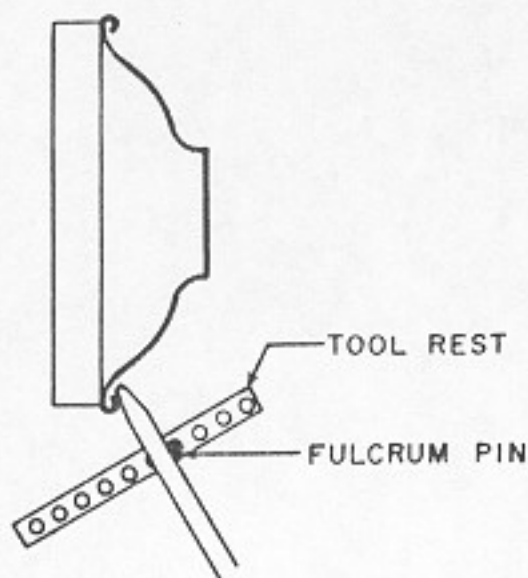


Fig. 9-9n. Apply pressure upward and sidewise against the bead, causing it to roll around until the edge of the metal touches the body of the object being spun.

ishing of copper, brass, or aluminum may be done with number 000 steel wool or 320 grit aluminum oxide cloth. This is followed with double duty buffing composition that has been applied to a paper towel. Hold the paper towel and composition against

the surface of the revolving metal until a high polish is obtained. Always use paper toweling, for it will tear if it becomes caught, and you will avoid injury. To polish the bottom of the project, remove the follow block and polish the bottom the same as you did the outside. After the bottom has been polished, the metal is removed from the chuck; it is turned around and the bottom is set against the chuck with the follow block inside the project. You can now polish the inside, following the same procedure as used on the outside.

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Rolling a Bead on the Edge of a Spun Object

When a bead is to be rolled, add about one-fourth of an inch to the radius of the disc before cutting. Lock the disc in the lathe and spin the metal to the chuck. Trim the edge so that the metal for the rolled edge is projecting out from the chuck. The exact amount of projection for a rolled edge is difficult to determine; it is a matter of experimenting. After the amount of projection has been decided, hold a hardwood stick with rounded end against the right side of the metal and at about the center of the bead. With the backstick against the left side and at the outer edge, force the rim back and slightly to the right as shown in Fig. 9-9k. You can now roll over the edge, using the backstick (see Fig. 9-9l, m, and n) or the beading tool (see Fig. 9-9o). After forming the bead, remove the project from the chuck (see Fig. 9-9p).

Questions

1. Why must a tailstock live center be used when spinning?
2. Explain the use of the fulcrum pin when spinning. Why does the metal spinner use two fulcrum pins?
3. Name the three different kinds of metal spinning chucks and explain their use.
4. What is the purpose of the follow block?

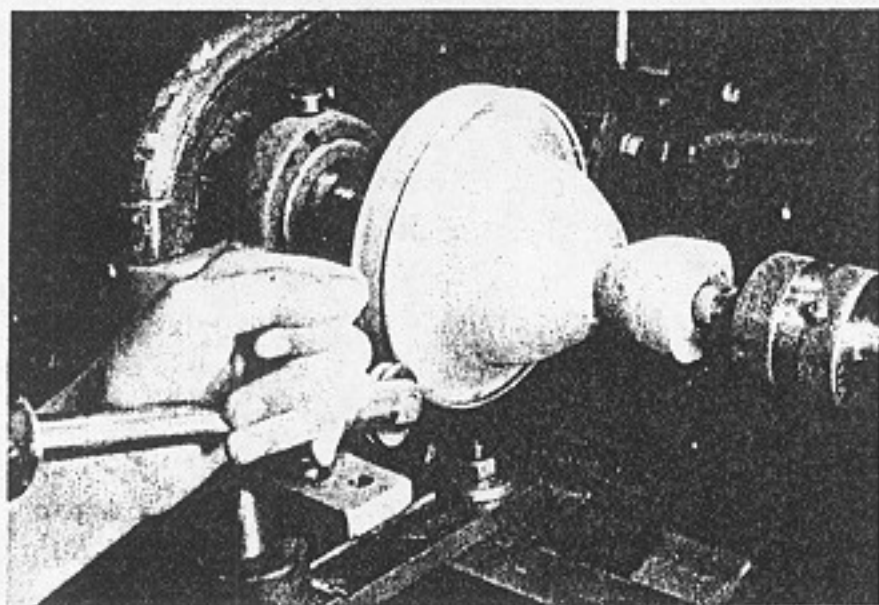


Fig. 9-9o. A beading tool may be used when rolling a bead.

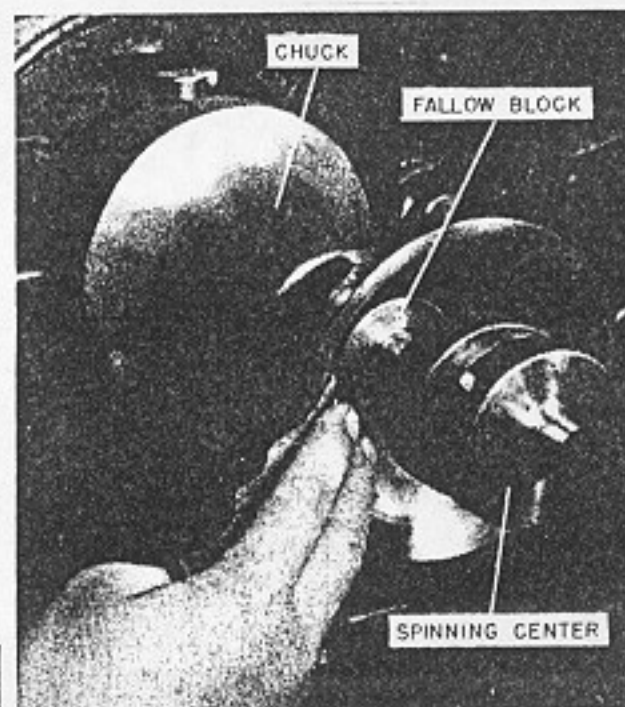
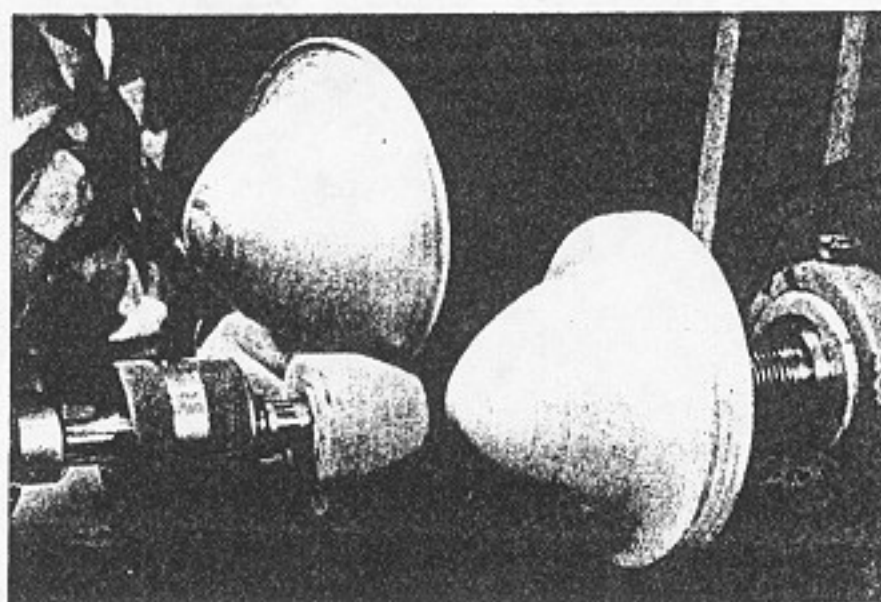


Fig. 9-9q. In polishing the inside of the project, the operator must be careful, as the revolving edge is sharp.

Fig. 9-9p. A spun lamp shade before final polishing.



5. How can you determine the size of the metal disc for use with each chuck?
6. What two methods can be used for centering the disc between the chuck and follow block?
7. Name the material used as a lubricant for the disc when spinning.

8. What is the purpose of the backstick?
9. Explain the reason for working the tool toward the center of the metal and then away from it when spinning.
10. From what materials are the chucks for spinning usually made?

CHAPTER 10

Ornamental Iron Work

This chapter covers the following subjects:

Designing the Scroll, 119 • Bending Tools and Their Uses, 119 • Fastening and Decorating, 122

Designing the Scroll

Ornamental iron work is an ancient craft. To be attractive, the

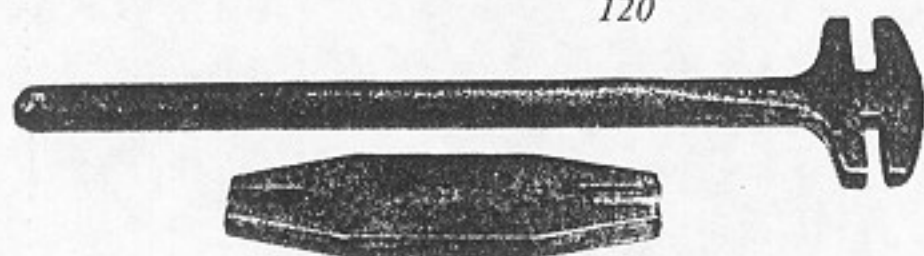
piece must be carefully designed. The design you select should be drawn carefully on heavy paper or, better

Bending Tools and Their Uses

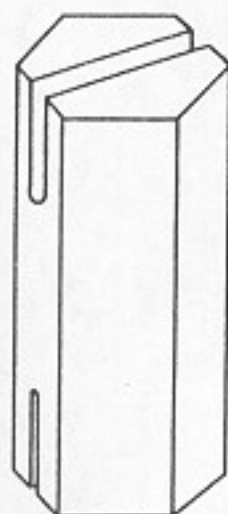
Wrought iron or band iron, which is usually used for ornamental work, can be formed into shapes without heating. This is called cold bending. The hammer, vise, wrenches, anvil, and the bending fork set (see Fig. 10-1a), bending jig (Fig. 10-1b), or bending forks (Fig. 10-1c and d) are the tools used by the craftsman to obtain the graceful bends and scrolls of metal that look so well.

Using a Monkey Wrench and a Vise to Twist Flat or Square Metal. The spiral twist is an attractive decoration. This twist can be made by putting the metal in the vise with the location for one end of the twist even with the edge of the vise jaw. Then grip the metal with a monkey wrench at the other end of the twist. Turn the wrench, twisting the metal to the desired spiral (see Fig. 10-2). Be sure to count the turns if you want to make another piece just like it.

Using an Anvil or Vise to Bend Hot Metal to a Right Angle. To



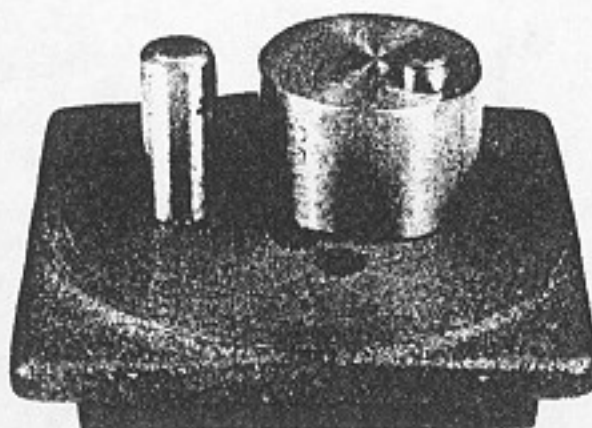
(a) Bending fork set.



(c) Bending fork made of hexagon bar stock.



(d) Bending fork made of a piece of pipe.



(b) Bending jig.

Fig. 10-1. Bending Fork and Jig.

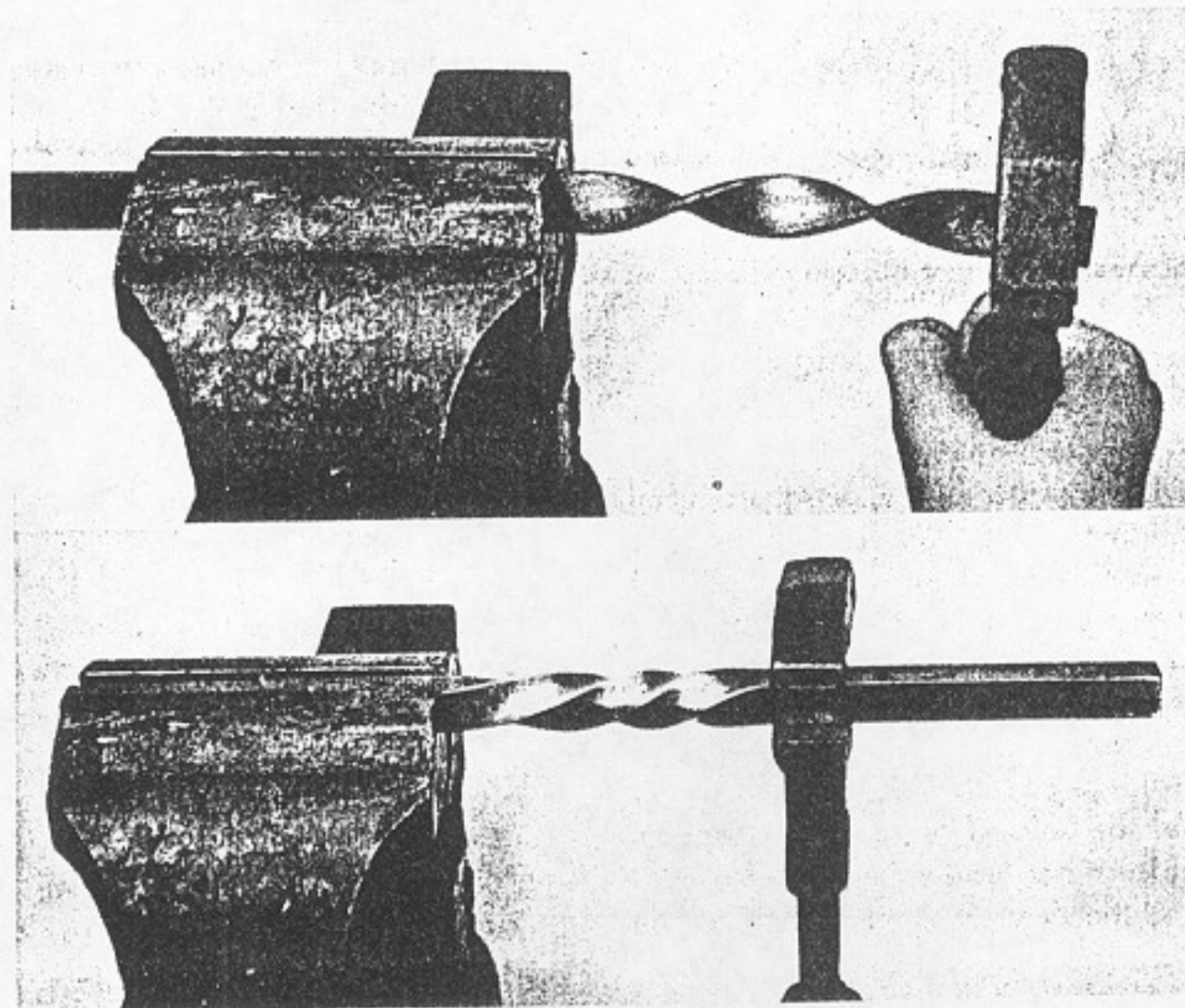


Fig. 10-2. Twist the metal only as many turns as are needed to make it pleasing to the eye.

bend hot metal to a right angle, first locate and mark the position of the bend. Then heat the metal and hold this mark on the edge of the anvil. Bend the metal down by striking it with a hammer, using the top and side of the anvil until the bend is made (see Fig. 10-3a). Sometimes it is easier to make this bend if the metal is held in a vise (Fig. 10-3b). However, take care not to strike and damage the vise.

Using a Hammer to Flare the Ends of a Bar of Metal. If you will closely examine some good pieces of ornamental iron work, you will note that the ends of the pieces have been flared. Flaring should be done before the bending operation is begun. To flare the ends of a bar, first measure the distance to be flared and place a mark at this location. Next, hold the end being flared close to the back edge of a solid surface, such as an anvil. Now, starting at the center and using a cross peen hammer, strike blows that fan out toward one edge. Now, do the same toward the opposite edge (see Fig. 10-4). The marks made on the metal by the peen are left for ornamental effect.

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Bending Fork Set and Bending Jig. The bending fork set (see Fig. 10-1a) and bending jig (Fig. 10-1b) are tools designed for bending flat bar stock into curves and scrolls. Metal up to $\frac{1}{4}$ " in thickness and 1" wide can be bent with these tools. A piece of hexagonal steel (Fig. 10-1c), or even gas or water pipe that has been slotted on either or both ends, will make an excellent homemade bending fork for light metal.

Using a Bending Fork Set and Vise or a Bending Jig. When bending flat bar stock, it is best to have the design you are going to follow on the bench, so that you may test the curves as you work. Study a, b, c, and d of Fig. 10-5 carefully. Any one, or a combination of these tools, may be used in bending metal. Sometimes a wrench can be used to good advantage to exert

pressure in producing the bends. There is no set rule to follow because every curve is different. It will require your ingenuity and much practice. The important thing to determine on every job is what curve to make first. Sometimes, if you start in the wrong place, making the other bends is difficult.

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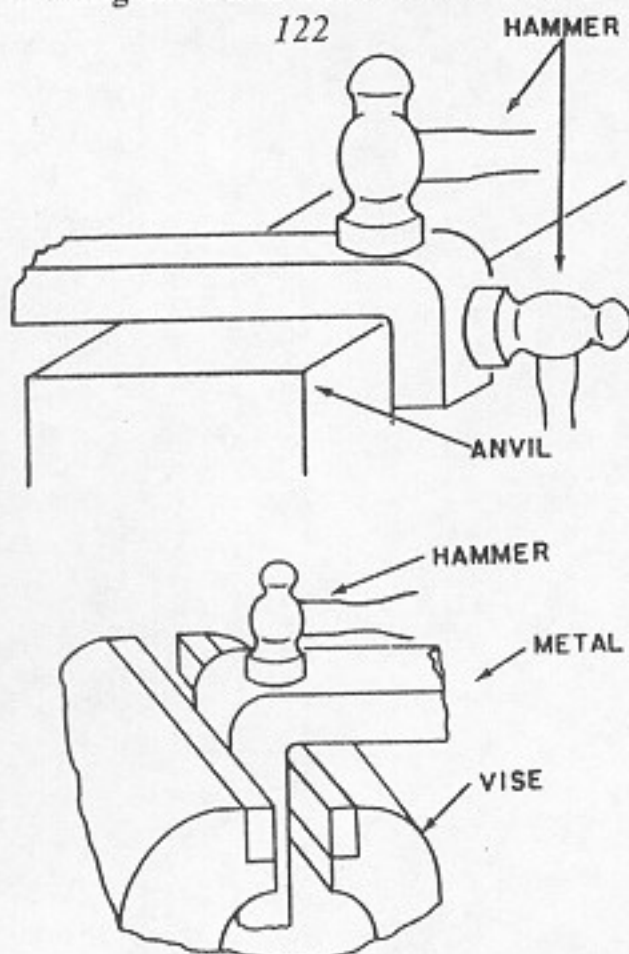


Fig. 10-3. Wrought iron that is being bent hot should be kept at a bright red color.

Fastening and Decorating

Using Rivets to Fasten Pieces of Bar Metal Together. To rivet two

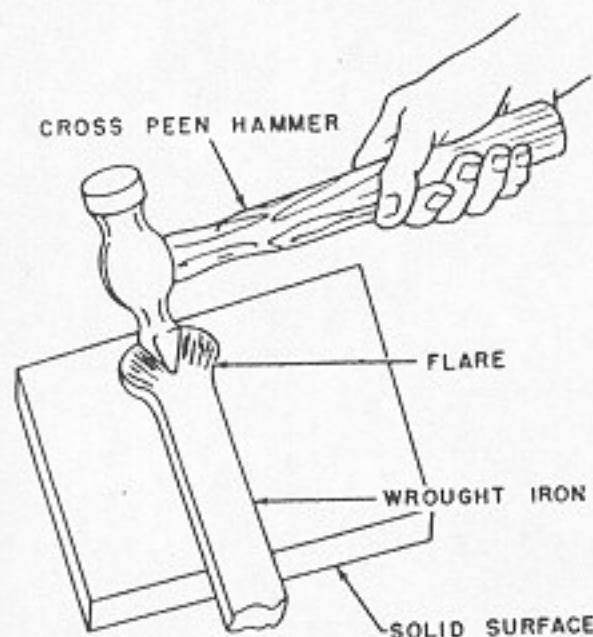
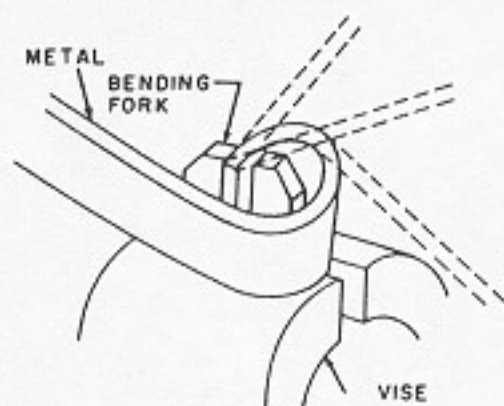
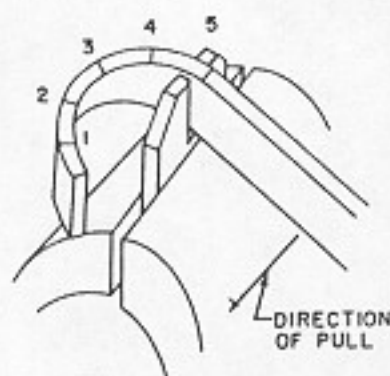


Fig. 10-4. The flare is only for appearance; for this reason, flare the end only enough to make it pleasing to the eye.



(a) Bending metal with a bending fork.



(c) The first bend is at point 1, the second bend at point 2, and so on until the bend is made.

(d) It is always easier to bend thick metal by pulling on the handle of the bending fork than by pulling the metal by hand.

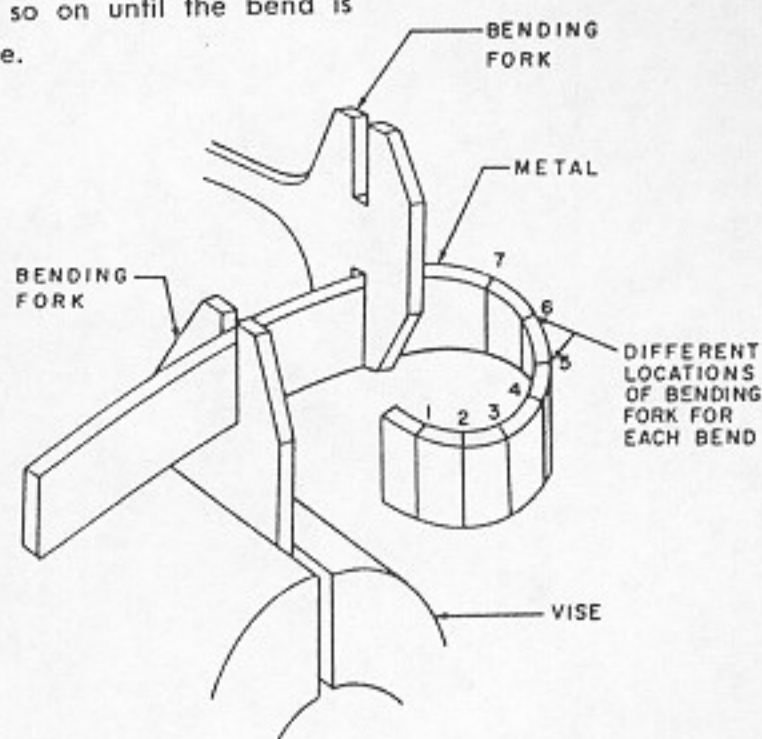
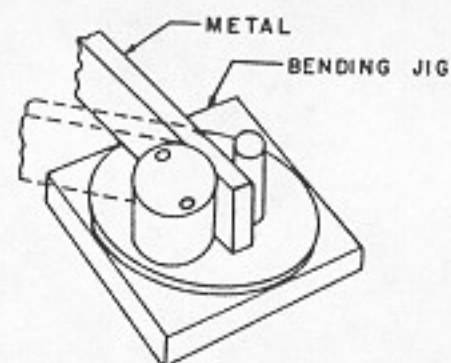


Fig. 10-5. The curves for the design are made by experimental bending and frequent comparing with the design.

or more pieces of flat or square metal together, it is necessary to use the proper rivet length, rivet size, and rivet head (see "Rivets—kind and size"). When you know the size, length, and shape, you can drill the necessary holes for the rivets (see Fig. 13-35, page 168). Then insert the rivet into the hole. The head of a countersunk or flat head rivet is placed on a solid metal surface (see Fig. 10-6a and b). If a round head rivet is being used, the head should be placed in the round depression found in the end of a sheet metal rivet set (see Fig. 10-6c). This prevents the round head from becoming flattened during the process of riveting. Now set the rivet by striking

a few sharp hard blows with a hammer. If you wish to make a flat or countersunk head, continue hitting with the hammer until the proper shape is obtained (see Fig. 10-6a and b). For the round head, use the peen end of the hammer (see Fig. 10-c).

Welding. Ornametal iron work is often fastened together by oxyacetylene or electric arc welding. When these methods are used, the edges of the two pieces being joined are melted with the flame until the molten metal runs. As soon as this happens, the flame is removed, allowing the molten metal to cool. In this way, the two pieces are securely joined. (See "Oxyacetylene and Electric Arc Welding.")



(b) Bending metal with a bending jig.

Decorating. Ornamental iron surfaces can be decorated by hammer marking (see Fig. 8-12, page 97), but it is necessary for all such marking to be done while the piece is flat and straight.

Finishing. Several different types of finishes can be applied to an iron surface. The most common and practical one for a school shop is the scorched oil or flat black lacquer finish. (See "Metal Finishing.")

Questions

1. Why are the ends of metal bars flared?
2. How long should a $\frac{3}{8}$ " diameter round or flat head rivet be when riveting two pieces of metal together if each piece is $\frac{1}{8}$ " thick?
3. How long should a $\frac{1}{4}$ " diameter countersunk rivet be when you rivet two pieces of metal together, if each piece is $\frac{3}{16}$ " thick?
4. When bending metal to make scrolls, why is it best to have the design close to where you are working?

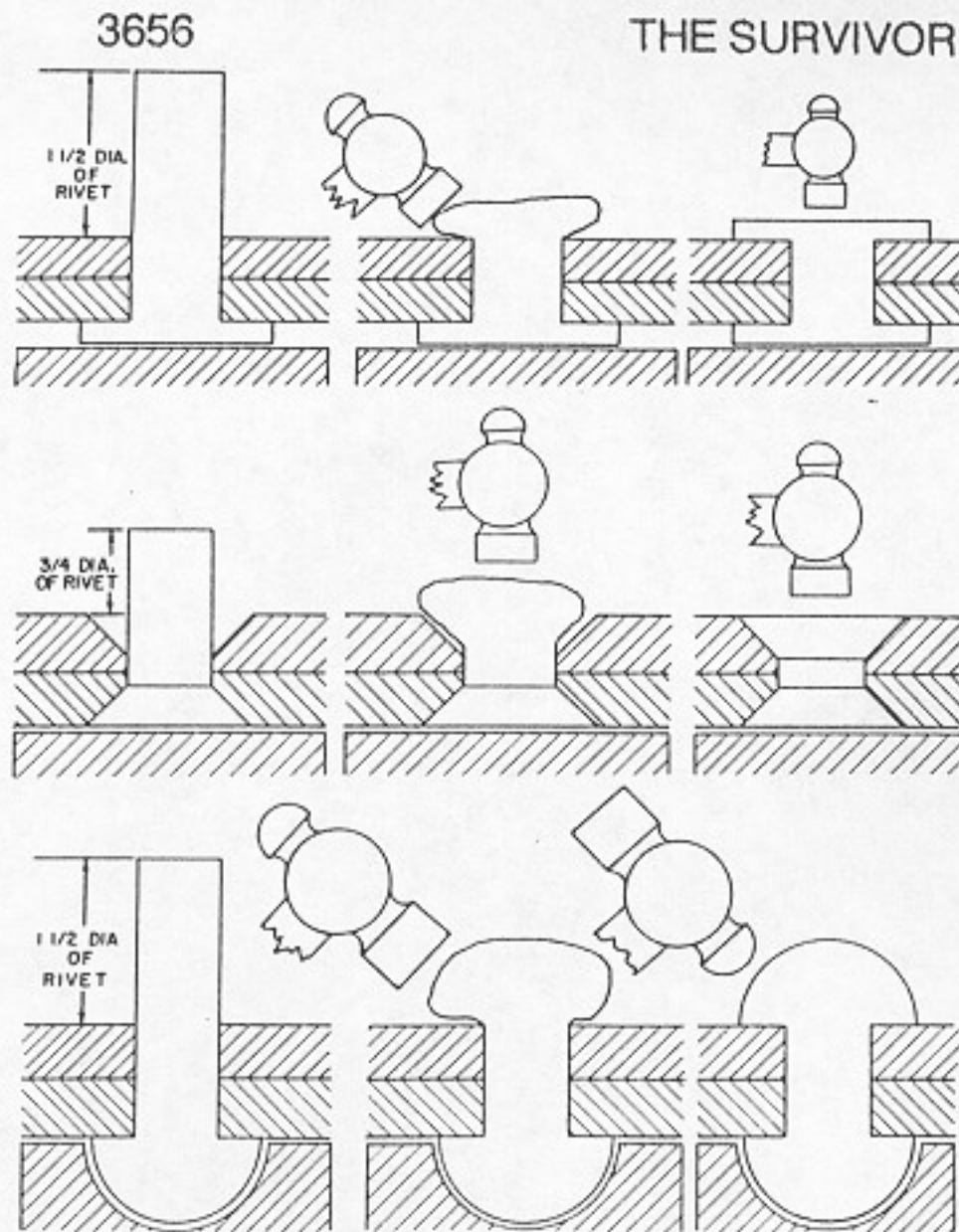


Fig. 10-6. The soft iron round or countersunk head rivet is generally used for ornamental iron work.

C H A P T E R



Heat Treating

This chapter covers the following subjects:

Heat Treating Equipment, 125 • Annealing, 125 • Hardening, 125 • Tempering, 125 • Case Hardening, 128

Heat treatment is the science of heating and cooling steel to make it either hard or soft. For instance, the blade of a knife has been heat treated; if it were not, it would not be hard enough to hold a sharp edge. Now, let's think about the tools with which you work. The steel of these tools had to be soft to begin with or it could not have been shaped into useful arti-

cles. After the tools were shaped, they were heat treated. Now, with these hardened tools we can make other tools, as long as the metal we are working on is softer than our tools.

Heat Treating Equipment

Heat treating is accomplished by heating the metal and then cooling it. The heat, in some instances, may be

furnished by a forge or a welding torch. However, special heat treating furnaces are usually used, as shown in Fig. 11-1.

Annealing

Annealing is the process by which hardened steel is made soft. This is done by heating the metal to a bright cherry red color and then allowing it to cool slowly (see Fig. 11-2).

Hardening

The process of controlling the degree of hardness of steel and steel alloys has become one of the most scientific processes in manufacturing. However, so far as amateur craftsmen are concerned it can be accomplished by heating the metal to a medium cherry red and then rapidly cooling it by quenching it in water or oil (see Fig. 11-3). This process produces a fine grain structure and extreme hardness.

Tempering

This is the process of removing some of the hardness from a piece of metal

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by heating. Tempering colors may be determined by watching the metal as it becomes hot. To see the colors during the process of tempering, the surface of the metal must have been polished. When tempering by the color method, an open flame or a red hot, heavy piece of steel is used to heat the metal. The heat may be applied by laying the metal to be tempered on top of the hot piece of steel or by directing the flame of a welding torch in back of or away from the polished surface. As the metal becomes heated, you will see the polished surface change from one color to another.

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As soon as the tempering color you are watching for appears at the point you are tempering, plunge the metal in the quenching liquid. Table 4 lists the different colors and temperatures that are used to temper metals for various uses:

TABLE 4
TEMPERING TEMPERATURES
AND CORRESPONDING COLORS

Color	Temperature	Use
Straw	428	Lathe tools, twist drills, finishing tools
Golden Yellow	469	Hammer faces, cold chisels for hard work
Purple	531	Cold chisels for ordinary use (carpenter tools)
Dark Blue	550	Hot chisels
Pale Blue	610	Springs, screw drivers

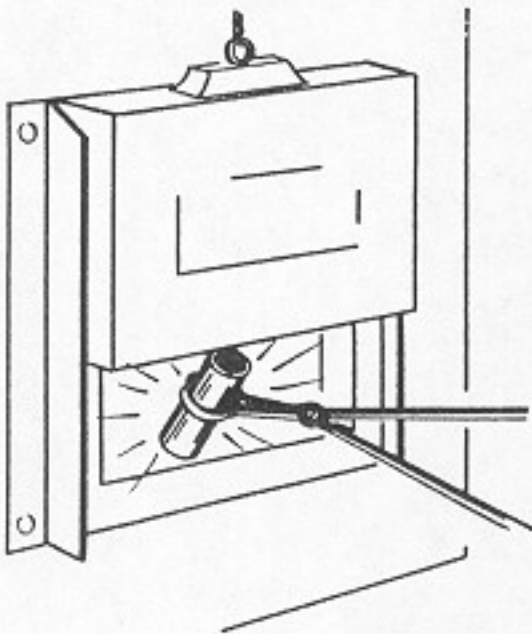


Fig. 11-2. To anneal, heat hardened steel to a cherry red (1400° Fahrenheit). Bury hot metal in lime, fine ashes, or another non-combustible material, or leave in a turned-off furnace until metal is cold.

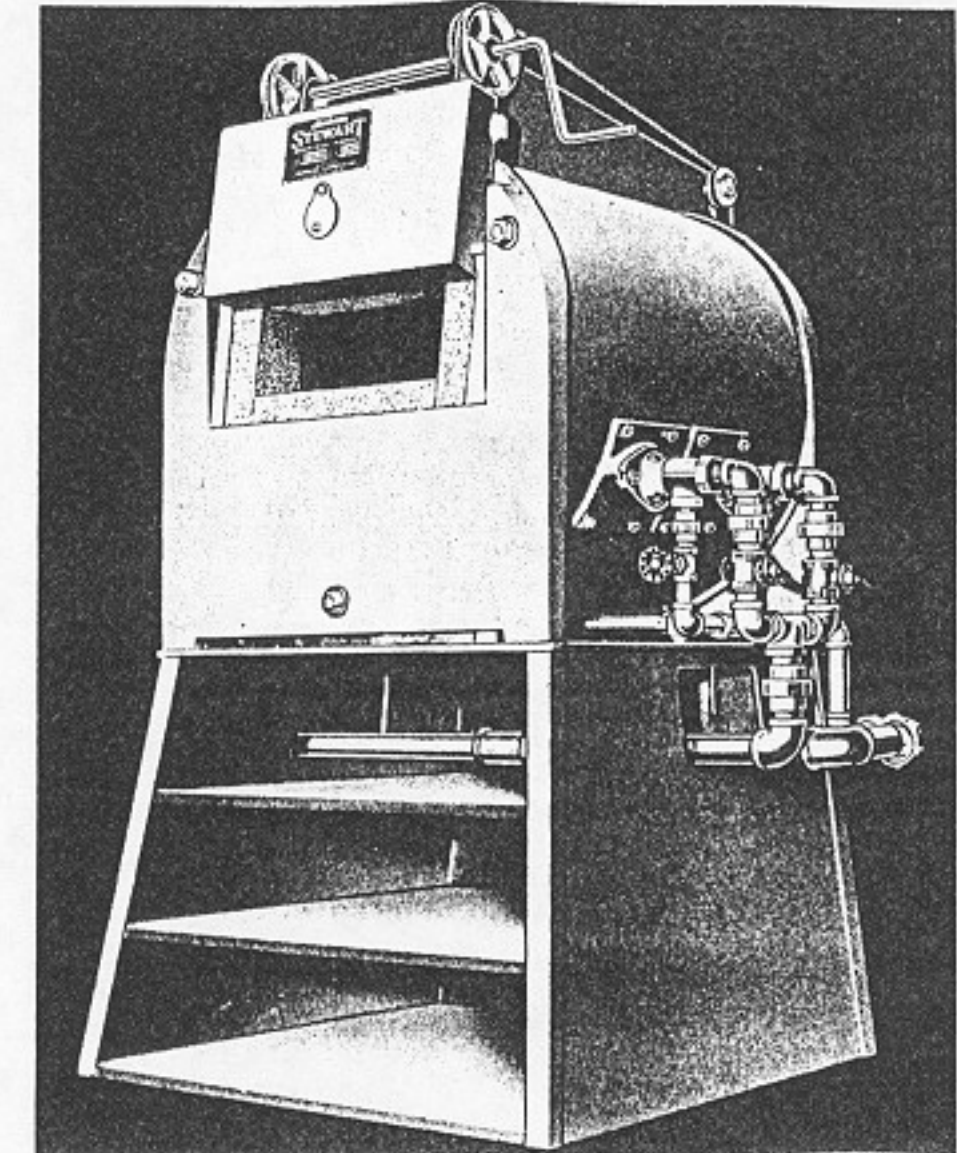
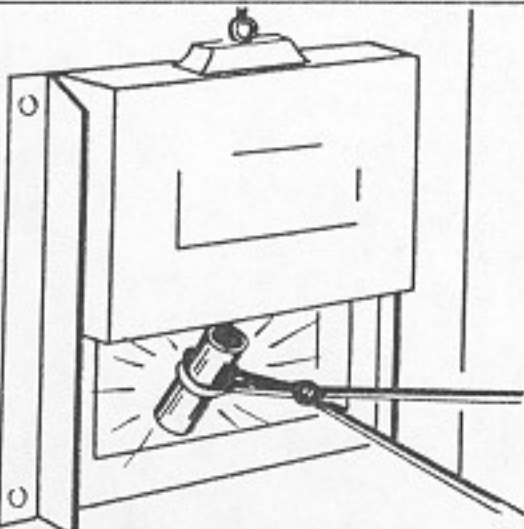
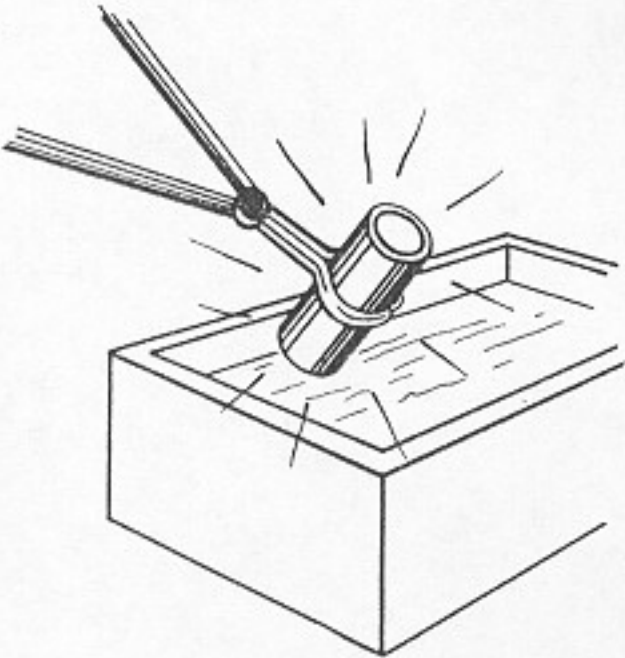


Fig. 11-1. Furnaces are used in heat treating steel. However, a welding torch can be used successfully on small jobs.



(a) Heat high carbon steel to a medium cherry red (1400° Fahrenheit.)



(b) Quench metal in clear cold water or oil. Move metal about in the water until cold.

Fig. 11-3. Hardening Steel.

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Case Hardening

Case hardening is a treatment given to soft steel to produce a hard outside shell.

Carbonizing, which is one of the methods used in case hardening, is the most practicable for school use. This method consists of keeping the metal hot while it is buried in a material that is high in carbon content.

The simplest method of case hardening consists of packing the soft steel in a carbonizing material in capped

pipes or metal boxes. These containers are then placed in a furnace and kept red-hot for a period of an hour or more. The longer the steel is left in the furnace, the thicker the hardened shell will be. When the container is taken from the furnace, it is allowed to cool slowly. After the metal has been removed from the carbonizing material, the outer shell can be hardened by following the same procedure as previously discussed under "Hardening."

Questions

1. Describe the process for hardening steel.
2. What is annealing?
3. What is meant by tempering and why do we temper steel?
4. What is case hardening?

C H A P T E R 12

Making Castings

This chapter covers the following subjects:

Patterns for Molding, 129 • Tools for Making a Mold, 129 • Foundry Sand, 132 • Making a Mold with a One-Piece Pattern, 133 • Making a Mold with a Split Pattern, 136 • Melting of Nonferrous Metals, 137 • Pouring of Molten Metals, 138 • Cleaning the Casting, 140

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You have observed that there are several ways to form metal into suitable shapes for our use. The sheet metal worker folds and cuts sheets and fastens the pieces together by riveting, soldering, or welding. The machinist uses metal cutting tools and machines to cut or form solid pieces of metal. The blacksmith forms metal by heating it and hammering it into shape on an anvil. It will be our purpose now to describe how metal parts can be made by casting, that is, by pouring molten metal into molds.

There are three distinct trades involved in producing a metal casting. First, the pattern maker makes a pat-

tern. Second, the molder makes a sand mold by pressing molding sand around the pattern. Third, the molten metal is poured into the mold by the foundryman.

Patterns for Molding

Patterns are usually made from materials that are easy to work and shape, such as soft pine wood. However, some are made of metal. They may be made in one piece, two pieces, or several pieces. The most common are the one-piece pattern and the two-piece or split pattern (see Fig. 12-1).

Tools for Making a Mold

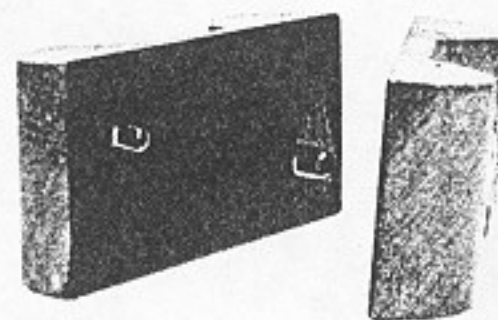
As in other trades, the molder works with tools that have been developed specially to aid him in his work. To hold the molding sand when making a mold, the molder uses a *flask*. This is a box-like wooden or metal frame, usually rectangular in shape, consisting of two parts, the cope and the drag (see Fig. 12-2a). In the figure, the cope is the bottom half and the drag is

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the top half of the flask. Since the flask does not have a top or bottom on it, *molding and bottom boards* are used. They must be as large as the outside of the flask and thick enough to support the weight of the sand. To move the sand from the pile and into the flask or riddle, a *molding shovel* is used. The



(a) One-piece pattern.



(b) Split pattern.

Fig. 12-1. Patterns for Molding.

riddle (see Fig. 12-2b) is a large sieve made of wood, with a heavy wire screen bottom. It is used to separate the moist sand into fine, loose particles as it is sifted or riddled over the pattern.

The *hand rammer* (see Fig. 12-2c) is used to pack the foundry sand in the cope or drag and around the pattern. The peen end assures the working of the sand below the surface. The butt end packs or rams the sand from the top surface to the molding board. After ramming, the sand is above the top edge of the cope or drag. To even

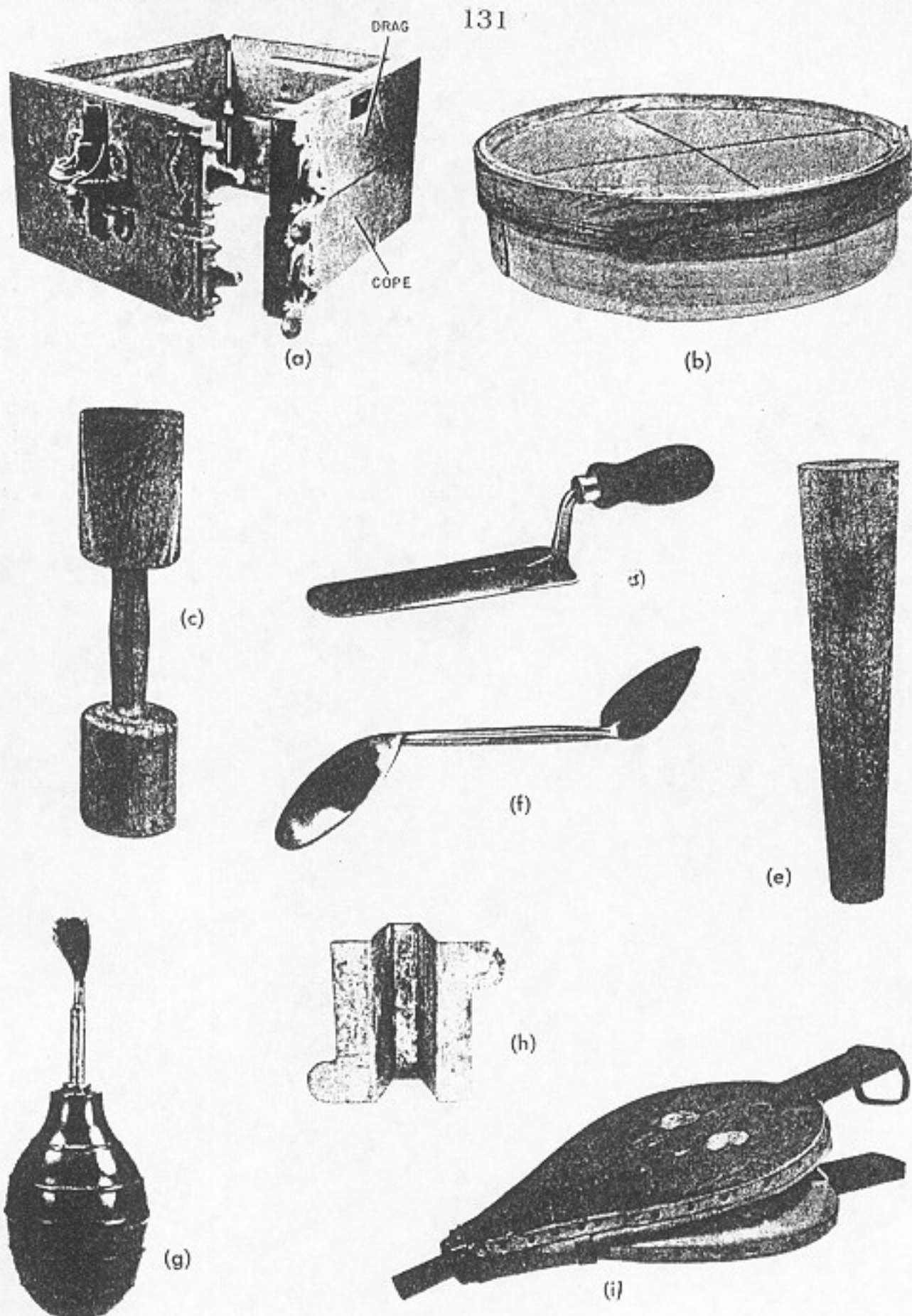


Fig. 12-2. Tools Used in Molding. (a) Flask. (b) Riddle. (c) Hand rammer. (d) Trowel. (e) Sprue and riser. (f) Slick and spoon. (g) Bulb sponge. (h) Gate cutter. (i) Bellows.

it off, a *strike off bar*, which is merely a straight piece of wood or metal longer than the width of the cope or drag, is used.

After the molding board has been removed, the *finishing trowel* (see Fig. 12-2d) is used to smooth the parting surface between the cope and the drag.

Moist sand sticks together. There-

fore, to keep the sand from sticking to the pattern and the parting surface between the cope and drag, a finely ground material known as *parting compound* is used. It is dusted over the parting surface of a mold and pattern from a cotton sack after the drag has been troweled.

The *sprue hole and riser cutters* (see

Fig. 12-2e) are tapered, cylindrical pieces of wood or metal tubes. In use, the sprue cutter makes a hole in the sand, into which the molten metal is poured. The riser makes a hole into which the hot metal rises to the top surface of the mold after it has filled the cavity made by the pattern. Venting the sand above and around the pattern in the cope aids in the escaping of gas and steam formed when the molten metal hits the damp sand. A wire with a sharp point makes a good *vent wire*. The *slick and spoon* (see Fig. 12-2f) is used to repair a damaged mold and to smooth around the pattern before lifting it from the sand.

The *bulb sponge* (see Fig. 12-2g) is used to swab or wet the edge of the mold before the pattern is lifted. Great care must be used while swabbing in order not to get the sand at the edge of the mold too moist. Too much

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moisture may be the cause of a poor casting.

A *gate cutter* (Fig. 12-2h) is a thin piece of sheet metal bent into the shape of a U. It is used to cut a channel, known as a gate, from the mold to the bottom of the sprue and riser holes.

Bellows (see Fig. 12-2i) are used to create a stream of air. In molding, loose particles of sand often fall into the mold. The bellows are used to blow these particles of sand out of the mold and off the parting surface.

Foundry Sand

The sand used when making a mold is known as foundry sand or molding sand. It is a special mixture of silica and clay. It should possess three qualities: (1) it must be refractory, which means that it will not melt at the high temperatures of molten metal, (2) it must have enough bond (clay) to hold the shape of the mold during the process of pouring the metal, and (3) it must be of a consistency that will permit the escape of gas.

Dry sand cannot be used for molding. It must be dampened by the addi-

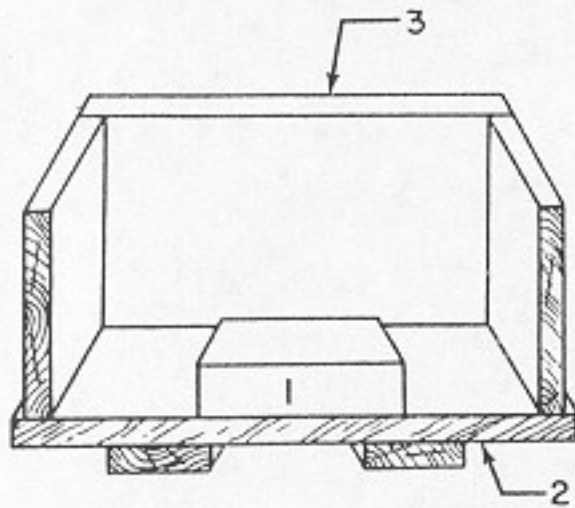


Fig. 12-3a. Pattern on molding board.

tion of enough moisture in the form of water to make the sand workable. This process is known as tempering the sand. To temper, wet the outside of the pile; then cut through the sand with a shovel. Cutting through is the mixing together of the wet and dry sand. To test the molding sand for proper temper, pick up a handful and squeeze it into a lump. Take hold of each end of the lump and break it in half. If the edges of the break remain firm and do not crumble, the sand has been correctly tempered. It is too dry if the edges break or crumble or if the lump falls apart. When the sand is too wet, it feels soggy and leaves the hand moist and muddy.

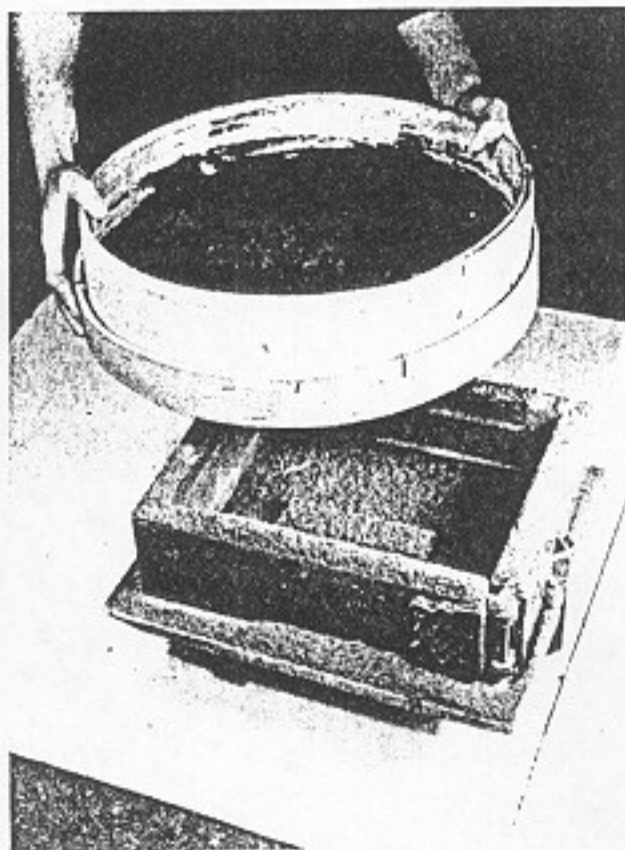


Fig. 12-3b. Riddling the sand.

Making a Mold with a One-Piece Pattern

The making of a mold, using a simple or one-piece pattern by the hand method, is shown in detail in Fig. 12-3. First, place the pattern 1 (see Fig. 12-3a) on the molding or pattern board 2. Make certain at the same time that the largest end of the pattern is against the board and in the drag of the flask 3. Note that the drag is placed with the guide pins down. Then, riddle the sand to a depth of about one inch over the entire pattern (see Fig. 12-3b) and press the riddled sand firmly around the pattern with the fingers. Next, fill the drag with sand (see Fig. 12-3c).

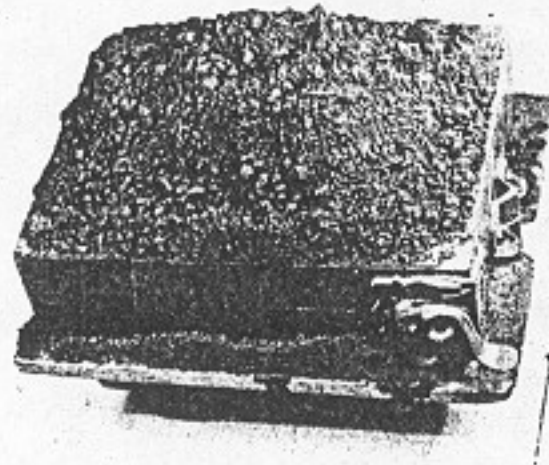


Fig. 12-3c. Drag filled with sand.

Then ram the sand around the pattern and the inside edges of the drag with the wedge-shaped end of the hand rammer as shown in Fig. 12-3d. Next pack the entire top surface of the sand with

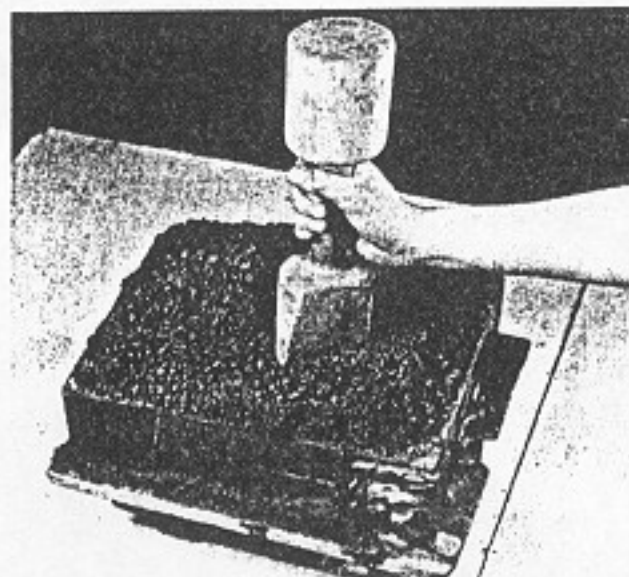


Fig. 12-3d. Ramming the sand around the pattern.

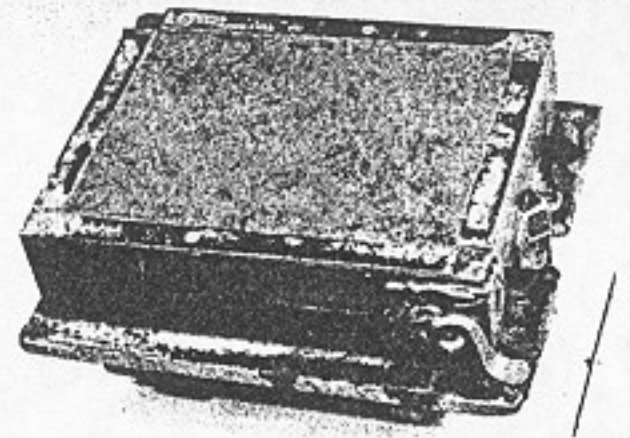


Fig. 12-3e. After excess sand has been struck off.

the opposite, or round, end of the hand rammer. The top of the packed sand should now be above the top edge of the drag. This excess sand must be removed or struck off in such a way that the sand is left level with the top edges of the drag (see Fig. 12-3e). To do this, use a strike off bar. Place the bottom board on top of the drag and, as you hold the molding and bottom boards on the drag with your hands, roll it over as shown in Fig. 12-3f. After the drag has been rolled and the molding board removed, the drag will remain on the bottom board (see Fig. 12-3g). The pattern is now exposed.

The slick and spoon is now used to smooth the sand (see Fig. 12-3h) where

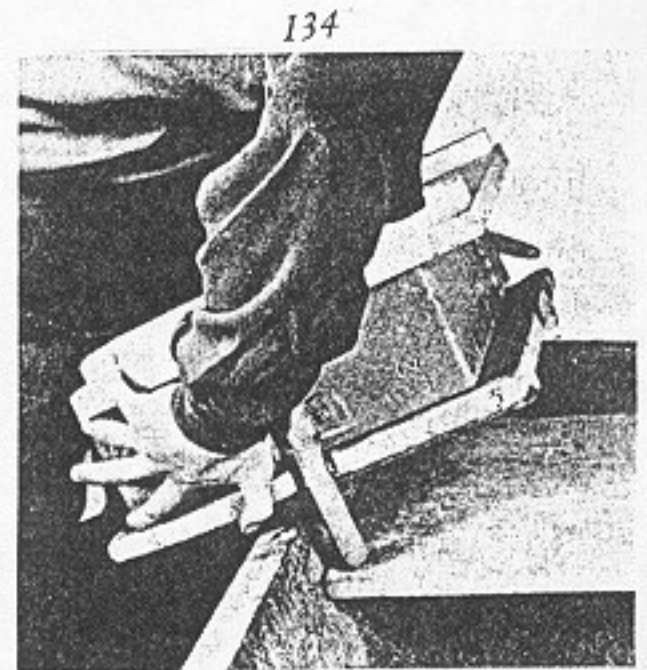


Fig. 12-3f. Rolling the drag.

it meets the edge of the pattern. Slick around the entire edge of the pattern to make certain that the sand does not hang over the edge and onto the pat-

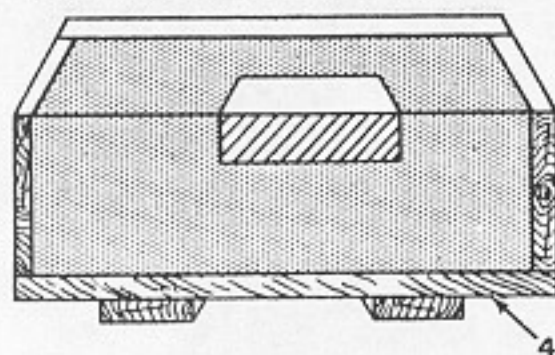


Fig. 12-3g. Drag turned over.

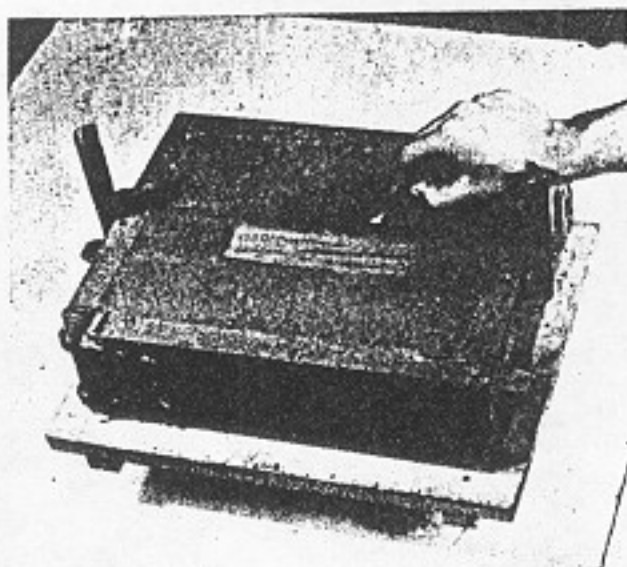


Fig. 12-3h. Smoothing sand around pattern.

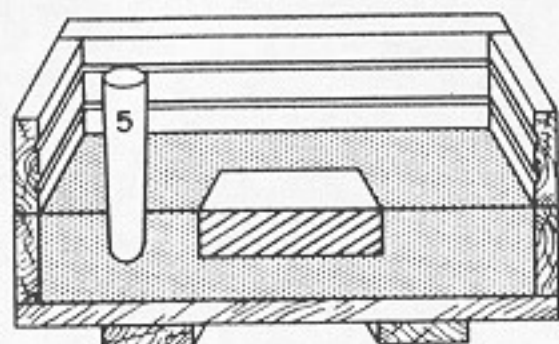


Fig. 12-3i. Locating sprue cutter.

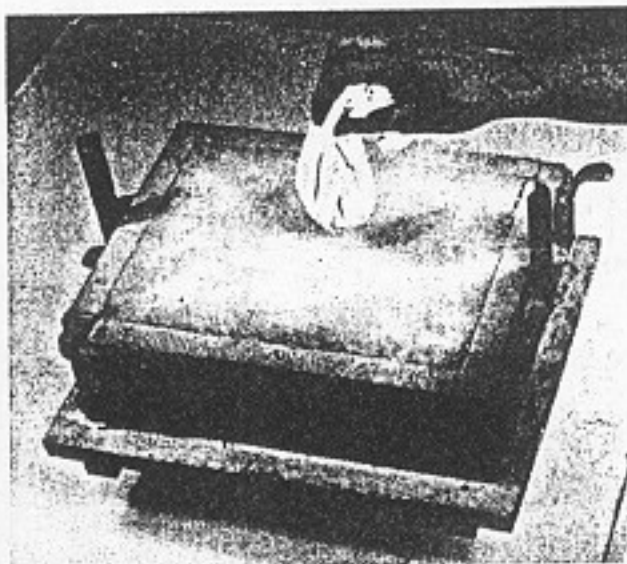


Fig. 12-3j. Dusting on parting compound.

tern. Next, the other half of the flask (see Fig. 12-3i), which is called the cope, is set on the drag, and the sprue cutter 5 is placed as shown in the drag and near the pattern. A light coating

of a parting compound is dusted onto the surface of the pattern and the sand as shown in Fig. 12-3j. This will prevent the sand in the cope from sticking to the sand in the drag. Now fill the cope heaping full of sand. Ram

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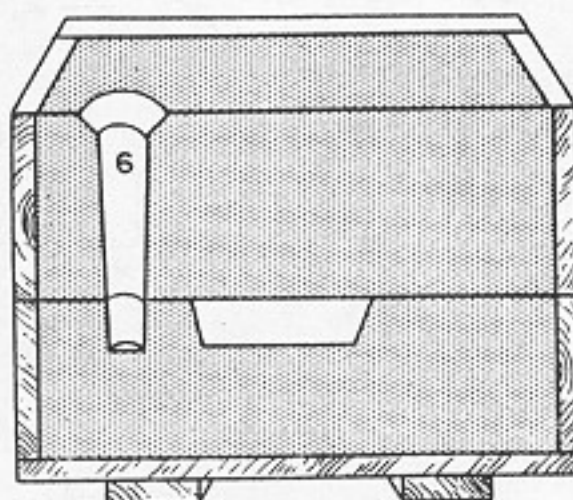


Fig. 12-3k. Funneling the sprue hole.

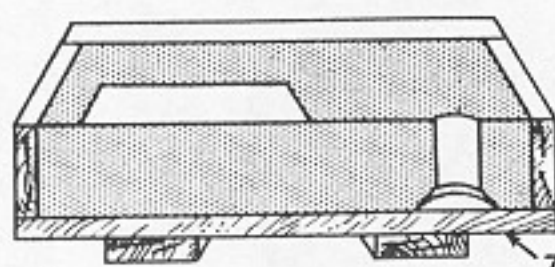


Fig. 12-3l. Drag removed from cope.

and strike off the sand the same as you did before. Rap the sprue cutter by hitting it lightly on all sides until it is loose enough to be pulled out of the sand. This leaves a hole 6 (see Fig. 12-3k), which is funnel-shaped at the top, as shown. It is therefore easier to pour the melted metal into the sprue hole. After funneling the sprue hole, lift the cope off the drag and stand it on its side or turned over on a board 7, as shown in Fig. 12-3l. If the cope is to be turned over, place the board on it before lifting. The bellows 8 (see Fig. 12-3m) or your breath may be used to blow off loose sand or parting material from both the cope and the drag. With a bulb sponge 9 (see Fig. 12-3n), water is dripped or swabbed lightly on the sand at the edge of the pattern. This extra moisture makes the sand more firm so that the pattern can be lifted without breaking the rim of the mold. Now turn the draw screw



Fig. 12-3m. Removing loose particles of sand.

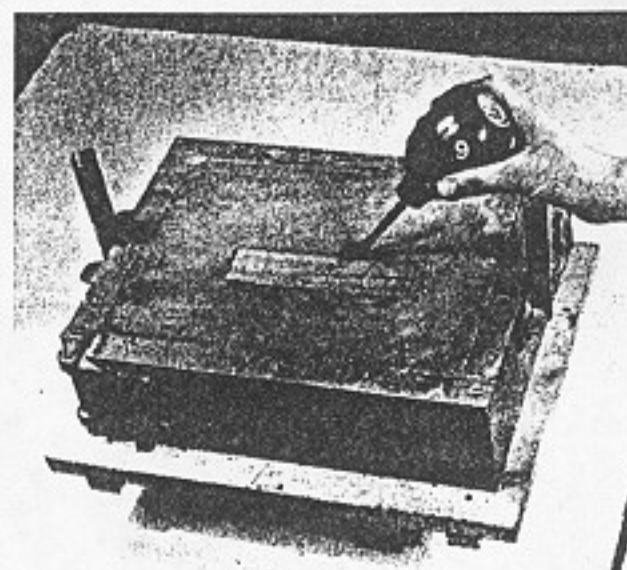


Fig. 12-3n. Swabbing around the pattern.

10 (see Fig. 12-3o) into the hole in the pattern. A few taps on the screw will loosen the pattern. By carefully lift-

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ing straight up on the draw screw, the pattern may be lifted from the sand. The cavity in the sand that was left by the pattern is the mold. A channel or gate 11 (see Fig. 12-3p) is cut in the sand to a depth of about three-eighths of an inch and one inch wide, connecting the bottom of the sprue hole with the mold. The cope is then carefully placed back on top of the drag, and weights (Fig. 12-3q) are put on top of the mold to keep the molten metal from raising the cope during the pouring process. You are now ready to pour the molten metal into the mold cavity. When the metal has cooled and the sand has been broken away from

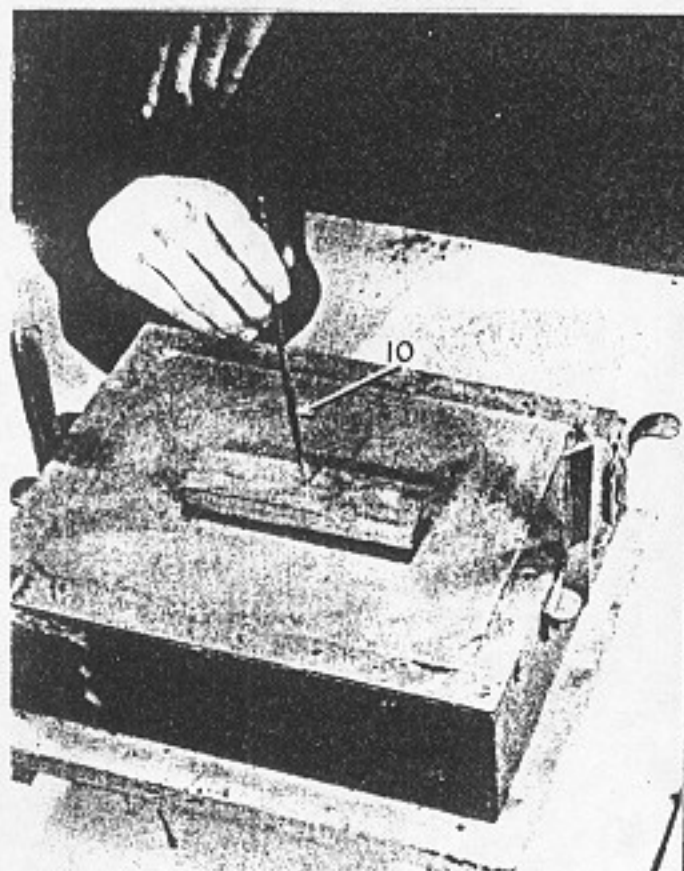


Fig. 12-3o. Lifting the pattern.

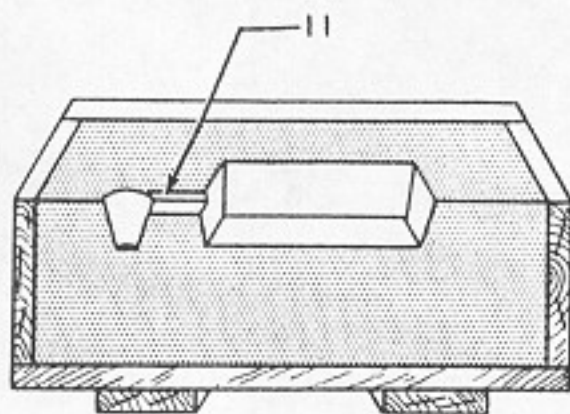


Fig. 12-3p. Cutting the gate.

the casting as shown in Fig. 12-3r, the sprue 12 and the gate 13 are either cut or broken off close to the casting. After that you should proceed to grind or file the remaining edges until they are smooth.

Making a Mold with a Split Pattern

A split pattern, as you have seen, is made in two pieces by being split down the middle. When you make a mold using a split pattern, the half without the dowel pins is placed on the molding board. Sand is molded around this half of the pattern in the same manner as steps 1 through 7 (see Fig. 12-3). The other half of the pattern with the dowel pins is now placed

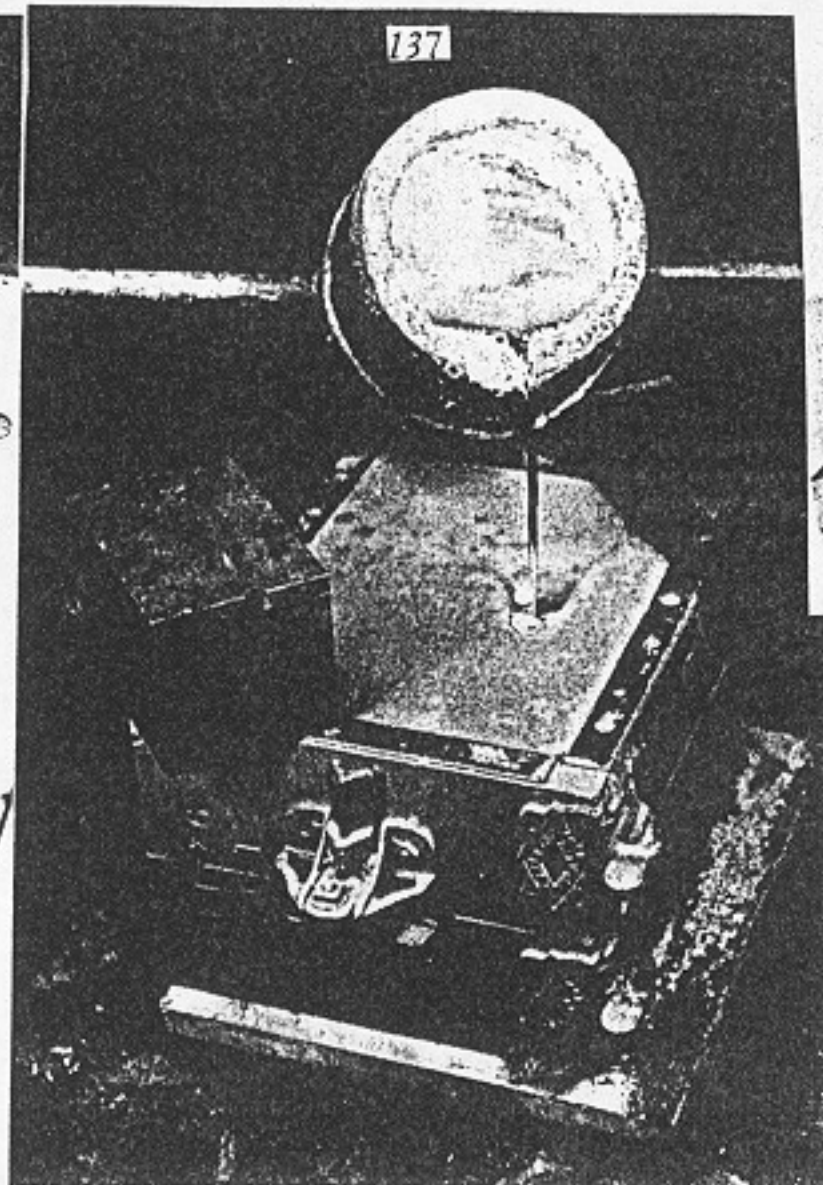


Fig. 12-3r. Casting removed from mold.

Fig. 12-3q. Weighting the cope and pouring the molten metal.

on the half that has had the sand molded around it. Make sure that the dowel pins fit into their proper holes in the other half of the pattern. Sand is then molded around this half of the pattern the same as in steps 8 through 15. In step 15, both halves of the pattern must be lifted from the sand. Then you should continue making the mold as indicated in steps 16 through 19.

Melting of Nonferrous Metals

Almost any metal can be melted and poured into a mold. Aluminum, which is preferred over cast iron because of its low melting point, is the metal most commonly used to make castings in the general metal shop. Because aluminum melts at 1,218 degrees Fahrenheit and because brass, which is sometimes used, melts at a temperature of between 1,700 and 1,850 degrees Fahrenheit, a melting furnace that will produce at least 1,900 degrees of heat is usually used. The melting furnace is cylin-

dric in shape with an opening in the top of the cylinder (see Fig. 12-4). Heat for the purpose of the melting of the metal is produced with electricity or by mixing air under pressure with gas. This will produce a temperature of approximately 1,900 degrees Fahrenheit. Since metal must be heated to certain temperatures before it will become molten, some means should be provided for determining how hot the metal is. This may be done accurately with a pyrometer (see Fig. 12-5.)

Temperatures of molten metal can be judged by their color. An experienced person can tell by looking at the metal whether it is at the right temperature for pouring. The visual method of judging temperatures is generally used in the school shop where pyrometers are not available. Metal must be melted in some form of container. A crucible is most generally used when nonferrous metals are reduced to a molten state (see Fig. 12-6).

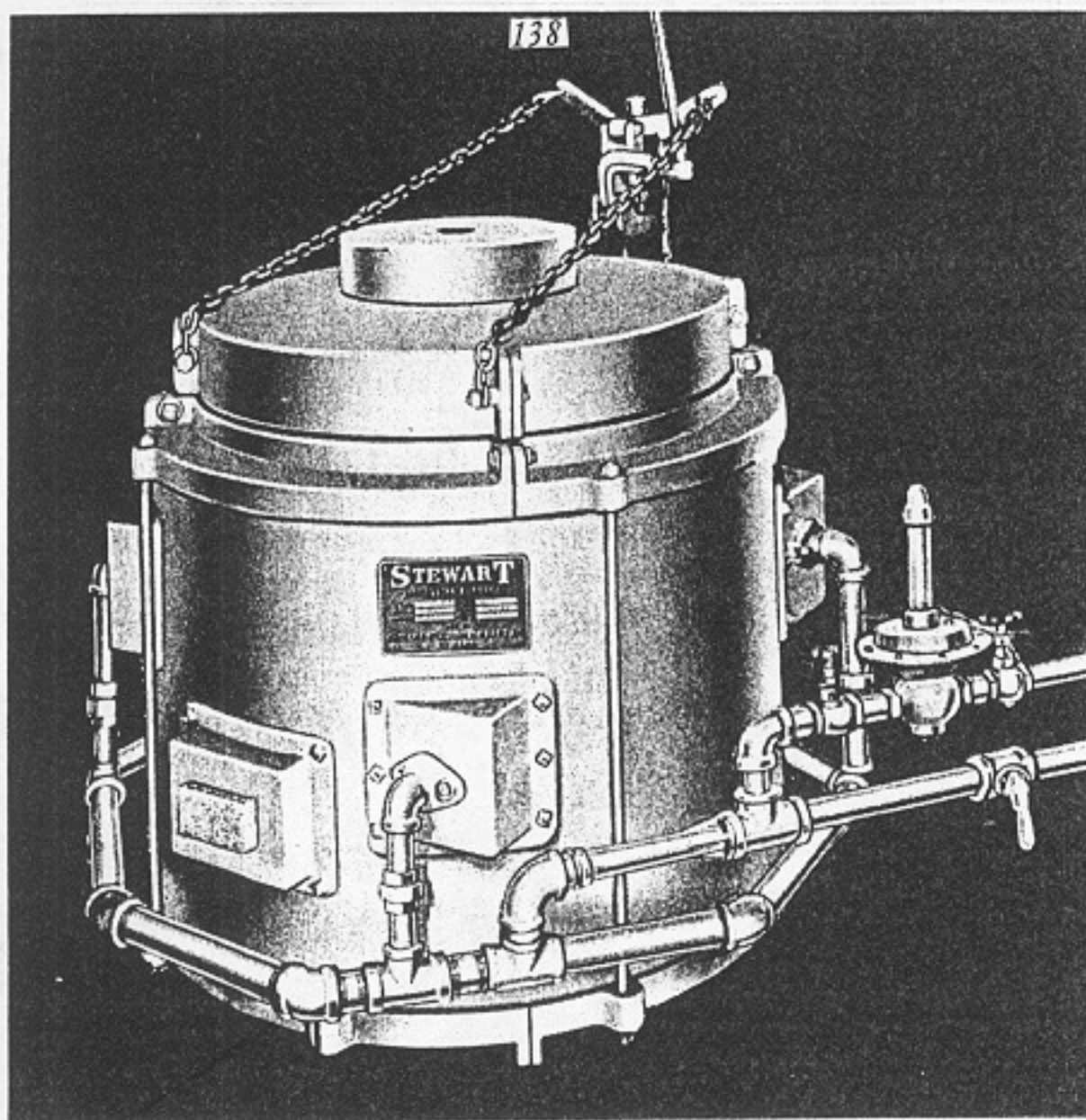


Fig. 12-4. Gas-Fired Melting Furnace. (Courtesy Sunbeam Corp.)

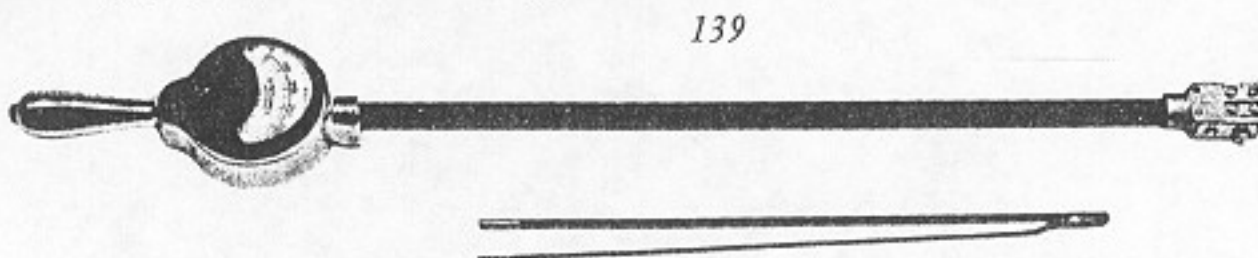


Fig. 12-5. The pyrometer is used for the purpose of measuring the temperature of molten metal.

Pouring of Molten Metals

The crucible containing the molten metal must be lifted from the furnace before the metal can be poured. To lift the crucible, *crucible tongs* (see Fig. 12-7a) are used. The crucible is then set into a crucible shank (see Fig. 12-7b). It provides a means for two persons to handle the hot crucible safely during the process of pouring. If the metal is aluminum, you may use an aluminum refining flux before pouring. This is a cleaning agent used to clean aluminum casting metal. The



Fig. 12-6. The crucible is made of fire-resisting clay or graphite.

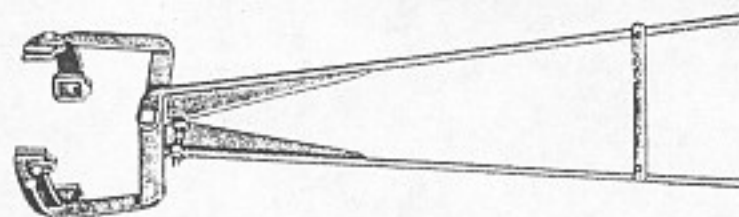
flux is sprinkled on top of the molten aluminum just before pouring. It is then stirred and the metal is skimmed. The use of this flux is not necessary if the metal was clean before it was melted.

Great care should be exercised in handling molten metal. It is very hot and will burn a person severely. Many schools require students always to wear goggles when pouring molten metal.

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Cleaning the Casting

After the metal has cooled, the sand is broken away from the casting. The



(a) Crucible tongs.



(b) Crucible shank, single end.

Fig. 12-7. Tools for Pouring Molten Metal. (Courtesy Industrial Equipment Co.)

casting is now in its rough state. Before it can be used, it must be cleaned. The extent of cleaning needed on the casting depends on what it is to be used for. If it is to be attractive and

have a high polish on it, the entire surface must be filed or sanded smooth before polishing. If it is intended for use as a machine part, the casting must be machined to specifications.

Questions

1. Explain in full how heat may be produced for the purpose of melting aluminum or brass.
2. Name two types of patterns.
3. What is parting compound used for?
4. For what reason are vent holes made in the sand above and around the pattern?
5. What three properties must all good molding sands possess?
6. Explain the reason for riddling sand over the pattern.
7. Explain the reason for rapping the pattern.
8. How can you tell if the sand is tempered properly?
9. At what temperature does aluminum melt?
10. Tell what is meant by nonferrous metals.

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C H A P T E R 13

Power Tools

This chapter covers the following subjects:

Power Hack Saw, 141 • Grinder and Grinding, 142 • Drill Press and Drilling, 144 • Engine Lathe, 154 • Shaper, 171 • Milling Machine, 181

Power-driven machine tools make it easy to form metal into desired shapes and sizes. You appreciate power if you drill a hole or saw a piece of metal by hand. There are a very large number of machines that have been developed to perform special operations, but we will study only six power tools—for, interestingly enough, all other machines are adaptations of one or more of these six machines.

Power Hack Saw

There are two types of power hack saws. One has a reciprocating stroke with a saw blade like the one used in the hand hack saw, only heavier (see Fig. 13-1a). This machine moves the blade back and forth with about the same stroke as is used when sawing by hand. The other type of power hack

saw has a blade similar to a band saw (see Fig. 13-1b). The blade does not move back and forth, but saws continuously.

Using a Power Hack Saw To use either type of a power hack saw, first measure and mark the length of the metal to be cut. Next, place the metal in the saw's vise, being careful not to tighten the vise. Carefully lower the hack saw blade to about one-sixteenth of an inch of the metal. Do *not* let the blade touch the work. Move the metal until the saw will cut just outside the measurement; then tighten the vise so that it will hold the metal securely while you are sawing. You are now ready to lower the saw blade onto the metal and start the saw.

Direct a stream of coolant right into the saw cut. The use of this coolant

is very important, for if the blade is kept cool, it will stay sharp much longer.

Watch the saw closely all the time the cutting is being done, and stop it as soon as the cut is completed. Always lift the blade to the "rest" position when not in use.

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Grinder and Grinding

A grinder driven by an electric motor is now usually used for the sharpening of tools and the smoothing or shaping of metal. There are two common types of grinders: the bench type (see Fig. 13-2a), which is fastened to the top of the bench, and the pedestal type (see Fig. 13-2b), which is fastened to the floor. Both of these are made in various sizes and for grinding wheels of different diameters. Most grinders are made to hold two grinding wheels, one wheel of a finer grain than the other, so that the operator can use the coarser one for rough grinding and the finer one for the smoothing or finish-sharpening of tools.

The grinder that is most commonly used in general metal shops is made for a grinding wheel 8 inches in diameter and is powered by a $\frac{1}{3}$ or $\frac{1}{2}$ horsepower motor with a speed of 1,750 revolutions per minute. This grinder, however, is not designed for heavy grinding. The heavy-duty grinder is usually equipped with coarse grinding wheels and is used for heavy grinding and the smoothing of castings. The tool rest should be set very close to the wheel. It is best to have no more than one-sixteenth of an inch of space between the tool rest and the wheel.

Some grinders are equipped with glass safety shields. A careful operator always protects his eyes with a glass safety shield or by wearing goggles.

To grind metal, hold or press it against the face of a revolving grinding wheel. As the sharp cutting particles of the wheel rub across the metal, they tear off small pieces. This causes heat to be generated, soon making the

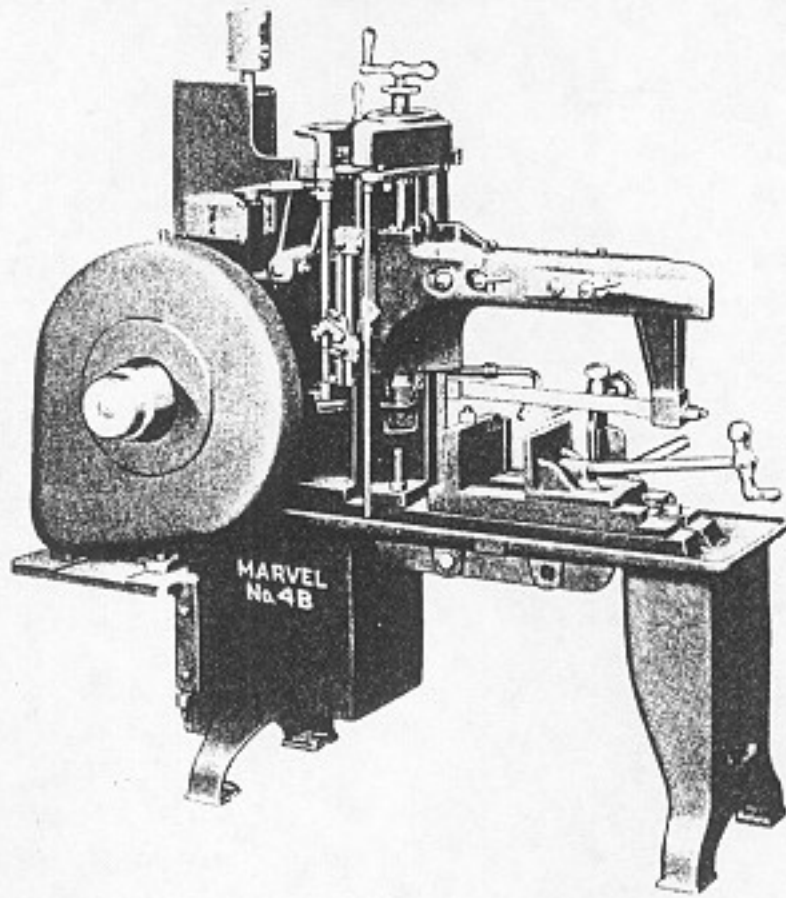
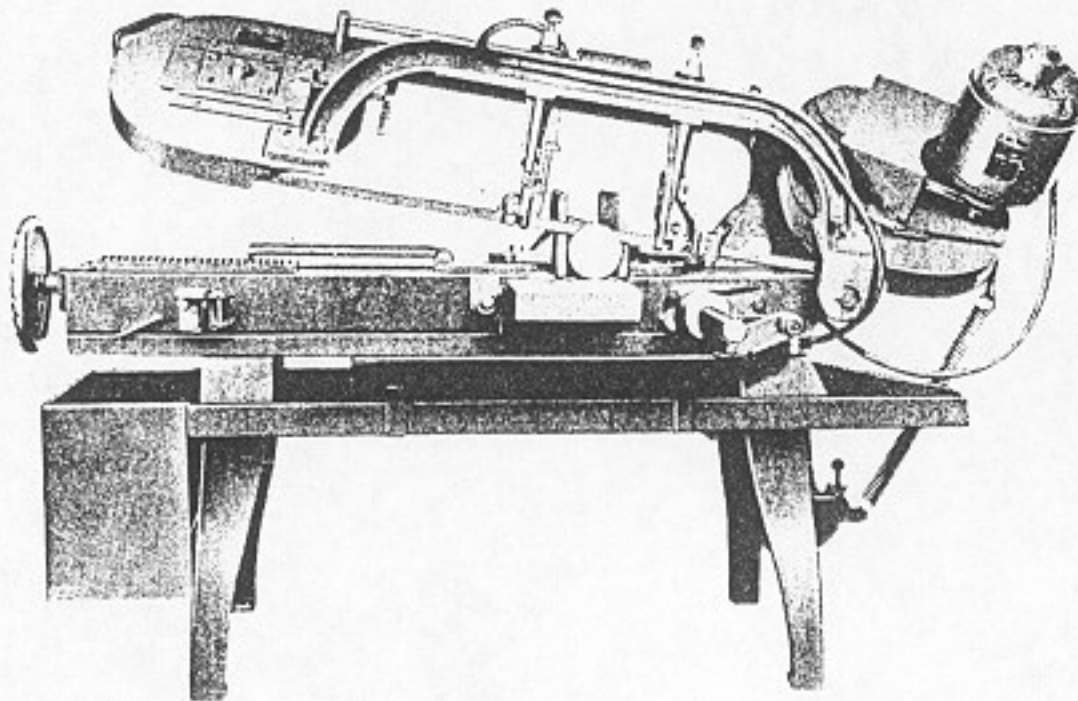


Fig. 13-1. Power Hack Saws. (a) Reciprocating type, left. (Courtesy Armstrong Blum Mfg. Co.) (b) Band saw type, below. (Courtesy Wells Mfg. Corp.)¹



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metal so hot that it cannot be held by hand. Furthermore, if cutting tools are permitted to become too hot, the temper in them will be ruined. Therefore, when you are grinding, you should keep the metal cool by dipping it frequently into water.

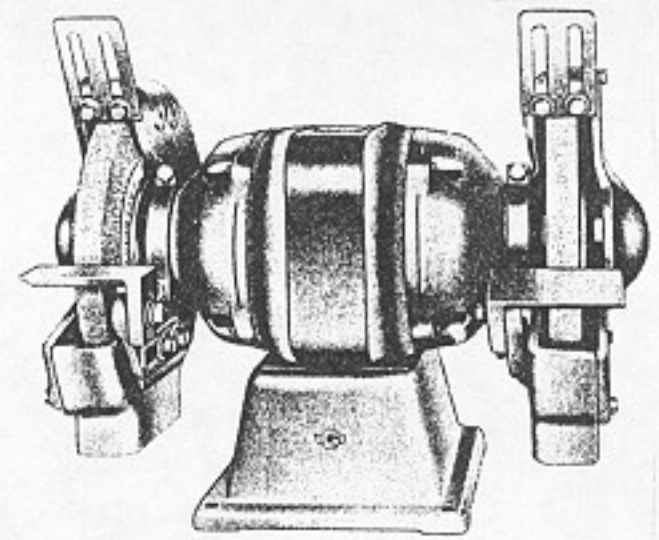
Either soft or hardened steel can be ground. For this reason, all tools that are hard, such as the knife in your mother's kitchen, your dad's chisel for

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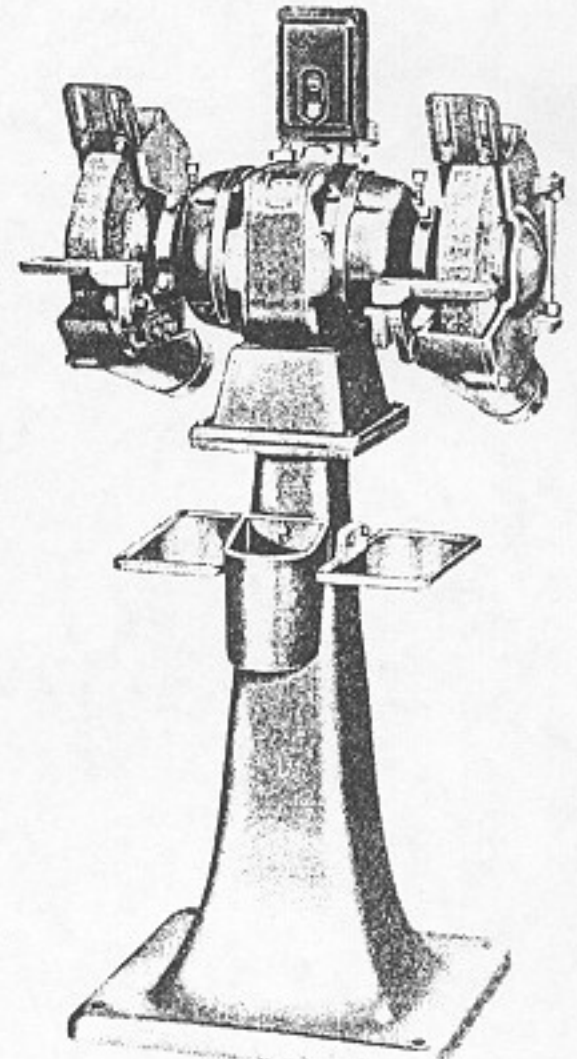
cutting wood, and the cutting tools used in metal working, can be sharpened on the grinder. Be sure they do not become overheated.

When a tool is to be ground, it is supported on the tool rest and moved in a straight line slowly back and forth across the face of the wheel. CAUTION: A GRINDER SHOULD NEVER BE USED IF THERE IS A GAP OF MORE THAN ONE-SIXTEENTH OF AN INCH BETWEEN THE FACE OF THE WHEEL AND THE TOOL REST. ALWAYS WEAR GOGGLES WHEN GRINDING. You can buy a new pair of goggles, but not a new pair of eyes.

Grinding Wheel Dressers. The mechanical grinding wheel dresser (see Fig. 13-3a) has several wavy steel discs or star shaped cutters mounted on an axle and separated by thin discs



(a) Bench grinder.



(b) Pedestal grinder.

Fig. 13-2. Grinders. (Courtesy Baldor Electric Co.)

of metal. These dressers are made in several different sizes, the most common of which has cutters $1\frac{1}{4}$ inches in diameter and is intended for dressing wheels up to 10 inches in diameter and with a 2-inch face. Another type of wheel dresser is the abrasive stick dresser (see Fig. 13-3b). It is used mostly on wheels of small diameter that are mounted on bench grinders.

Using the Grinding Wheel Dresser.

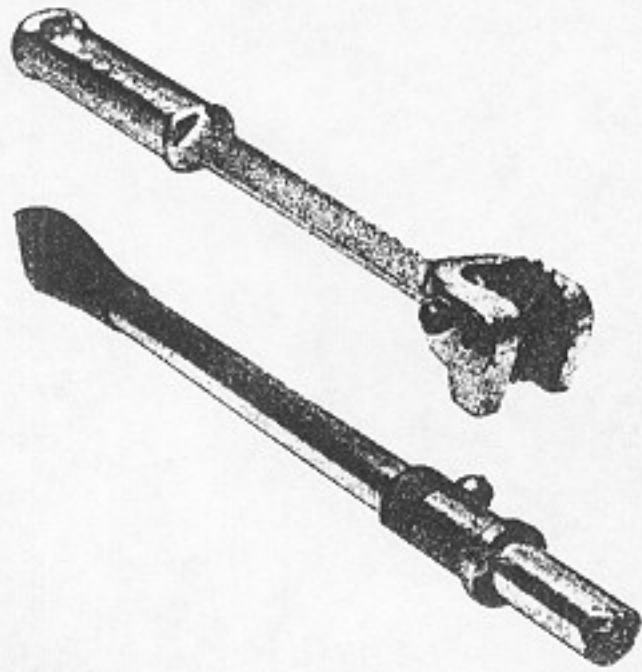


Fig. 13-3. If sparks appear when you are cleaning a wheel with a mechanical dresser, it means the wheel is grinding off the teeth of the revolving cutters. If this happens, use more pressure against the face of the wheel. (a) Huntington grinding wheel dresser. (b) Diamo-Carbo grinding wheel dresser.

The surface of a grinding wheel must be kept clean and straight. A grinding wheel dresser is used for two purposes: first, to true up the wheel, and second, to dress the wheel, which is to improve or alter its cutting action. In dressing, the outside layer of dulled abrasive grains and any loading of metal or foreign material that the wheel may

have picked up is removed. This permits new and sharp abrasive grains of the wheel to touch the work. The dressing of a grinding wheel may be thought of as sharpening it.

When using either of the wheel dressers, support it on the tool rest. The gap between the tool rest and the wheel should be no wider than one-sixteenth of an inch. Hold the dresser firmly and move evenly across the face of the wheel. Dress off the wheel sparingly, for one can easily waste away a good wheel by dressing too heavily.

Drill Press and Drilling

The drill is used to make a hole in a piece of metal, or to enlarge a hole

that already has been made. To do this, you must hold the drill either in a drill press or in some other turning device. Also, the material to be drilled must be supported and securely held, so that it will not turn. During the drilling process all of the cutting is done by the end of the drill as it revolves and is advanced into the metal. The material that is cut from the metal

to make the hole is called chips.

Twist Drill. The two most commonly used twist drills are the taper shank (Fig. 13-4a) and straight shank drill (Fig. 13-4b). In studying this Fig. 13-4b you will notice that the body 1 is composed of the flutes 2, lands 3, margin 4, cone point 5, and that the shank 6 is either straight or tapered, with a tang 7 on the end of the taper. The tapered shanks on drills conform to one of the tapers in the Morris taper series, which runs from a number 0 taper to a number 7 taper. The number 1 and 2 taper shanks are the ones most generally used in a general metal shop. This type of shank holds better than a straight shank drill, as the tang fits into a slot in the socket which keeps the drill from slipping.

Twist Drill Sizes. The diameters of twist drills are designated by numbers, by letters, and by fractions of an inch. The three different methods of indicating drill sizes are given in Table 5. By studying Table 5, you will note that the number drills range in between the fraction drills up to about $\frac{1}{4}$ of an inch and then the letter drills start and range up to about $\frac{7}{16}$ of an inch. With the combination of number, letter, and fraction size drills, holes of 138 different sizes can be drilled in between number 80, the smallest size drill, and $\frac{1}{2}$ inch. The drill size is stamped into the metal where the flutes join the shank, or right on the shank. If the size becomes marred or worn off, a drill gage may be used to determine the size of the drill (see Fig. 13-5).

Drill Grinding. The best way to learn how to drive a car is to drive one with someone riding with you to give you a few good tips on shifting, braking, turning corners, and stopping. Just reading how to do it will not make a good driver of you. The same is true of drill grinding.

To start, use a $\frac{1}{2}$ -inch drill that is properly ground. Now step up to the grinder and practice without the grinder running (see Fig. 13-6a). Hold

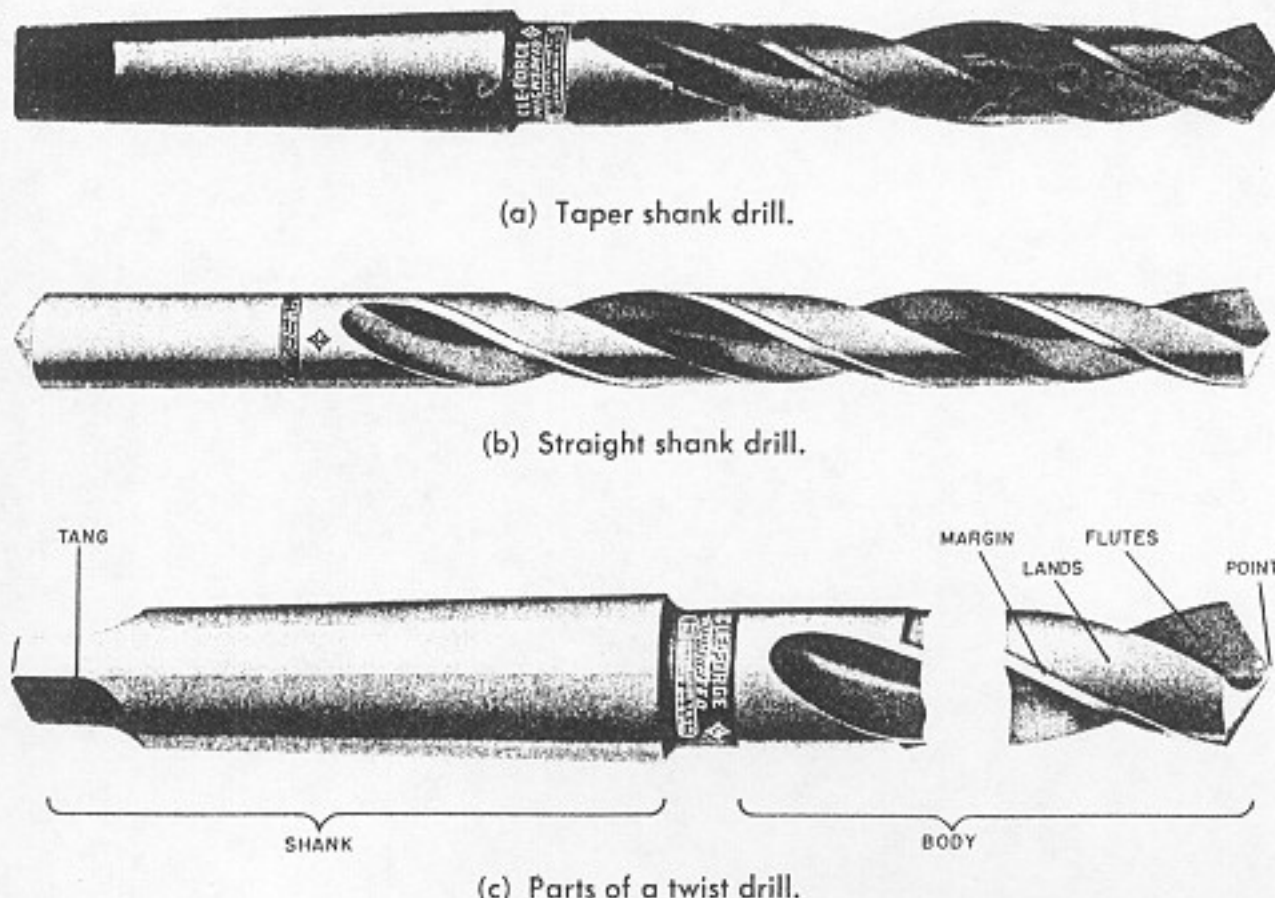


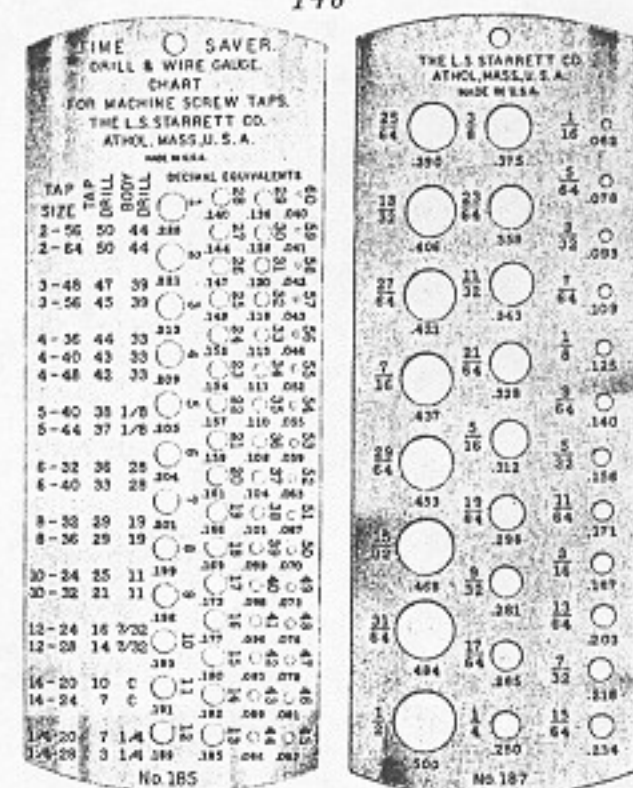
Fig. 13-4. Twist Drills and Their Parts. (Courtesy Cleveland Twist Drill Co.)

TABLE 5
DECIMAL EQUIVALENTS
OF WIRE GAGE, LETTER, AND FRACTIONAL SIZE DRILLS

Fractional Size Drills (Inches)	Wire Gage Drills	Decimal Equivalent (Inches)	Fractional Size Drills (Inches)	Wire Gage and Letter Size Drills	Decimal Equivalent (Inches)
1/64	80	.0135	9/64	30	.1250
	79	.0145		29	.1285
	78	.0156		28	.1360
	77	.0160		27	.1405
	76	.0180		26	.1406
	75	.0200		25	.1440
	74	.0210		24	.1470
	73	.0225		23	.1495
	72	.0240		22	.1520
	71	.0250		21	.1540
1/32	70	.0260	11/64	20	.1562
	69	.0280		19	.1570
	68	.0292		18	.1590
	67	.0310		17	.1610
	66	.0312		16	.1660
	65	.0320		15	.1695
	64	.0330		14	.1719
	63	.0350		13	.1730
	62	.0360		12	.1770
	61	.0370	3/16	11	.1800
3/64	60	.0380		10	.1820
	59	.0390		9	.1850
	58	.0400		8	.1875
	57	.0410		7	.1890
	56	.0420		6	.1910
	55	.0430		5	.1935
	54	.0465		4	.1960
	53	.0469		3	.1990
	52	.0520		2	.2010
	51	.0550	13/64	1	.2031
1/16	50	.0595		A	.2040
	49	.0625		B	.2055
	48	.0635		C	.2090
	47	.0670		D	.2130
	46	.0700		E	.2187
	45	.0730		F	.2210
	44	.0760		G	.2280
	43	.0781		H	.2340
	42	.0785		I	.2344
	41	.0810		J	.2380
5/64	40	.0820		K	.2420
	39	.0860		L	.2460
	38	.0890		M	.2500
	37	.0935		N	.2570
	36	.0937		O	.2610
	35	.0960		P	.2616
	34	.0980			.2656
	33	.0995			.2660
	32	.1015			.2720
	31	.1040			.2770
3/32	30	.1065	15/64		.2810
	29	.1094			.2812
	28	.1100			.2900
	27	.1110			.2950
	26	.1130			.2969
	25	.1160			.3020
	24	.1200			.3125
	23				.3160
	22				.3230
	21				
7/64	20				
	19				
	18				
	17				
	16				
	15				
	14				
	13				
	12				
	11				

the drill near the point between the forefinger and the thumb and place the back of the second or third finger on the tool rest. This steadies the drill. Hold the shank in the other hand and to the left as in the illustration. Move the point of the drill up to and against the wheel. Now turn the drill with the hand holding the shank until one of the cutting lips is horizontal or parallel to the grinder tool rest.

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(a) Drill gage for number or wire gage size drills. (b) Drill gage for fractional size drills.

Fig. 13-5. Drill gages are used to determine the sizes of number, letter, and fraction size drills that are smaller than 1/2" in diameter. (Courtesy L. S. Starrett Co.)

The shank of the drill should be lower than the drill point. Lower the drill shank while keeping the point of the drill in contact with the face of the grinding wheel. When the heel of the drill point comes into contact with the wheel, remove it. Repeat this several times until you have the knack of keeping the cone point in contact with the wheel during the process of lowering the shank.

When you feel that you are ready, turn on the grinder and do exactly the same things you did when the grinder was not running. However,

TABLE 5 (continued)

DECIMAL EQUIVALENTS
OF WIRE GAGE, LETTER, AND FRACTIONAL SIZE DRILLS

Fractional Size Drills (Inches)	Letter Size Drills	Decimal Equivalent (Inches)	Fractional Size Drills (Inches)	Letter Size Drills	Decimal Equivalent (Inches)
21/64	.....	.3281	19/32	.....	.5937
	Q	.3320	39/64	.....	.6094
	R	.3390	5/8	.....	.6250
11/32	.....	.3437	41/64	.....	.6406
	S	.3480	21/32	.....	.6562
	T	.3580	43/64	.....	.6719
23/64	.....	.3594	11/16	.....	.6875
	U	.3680	45/64	.....	.7031
3/8	.....	.3750	23/32	.....	.7187
	V	.3770	47/64	.....	.7344
	W	.3860	3/4	.....	.7500
25/64	.....	.3906	49/64	.....	.7656
	X	.3970	25/32	.....	.7812
	Y	.4040	51/64	.....	.7969
13/32	.....	.4062	13/16	.....	.8125
	Z	.4130	53/64	.....	.8281
27/64	.....	.4219	27/32	.....	.8437
7/16	.....	.4375	55/64	.....	.8594
29/64	.....	.4531	7/8	.....	.8750
15/32	.....	.4687	57/64	.....	.8906
31/64	.....	.4844	29/32	.....	.9062
1/2	.....	.5000	59/64	.....	.9219
33/64	.....	.5156	15/16	.....	.9375
17/32		.5312	61/64		.9531
35/64		.5469	31/32		.9687
9/16		.5625	63/64		.9844
37/64		.5781	1		1.0000

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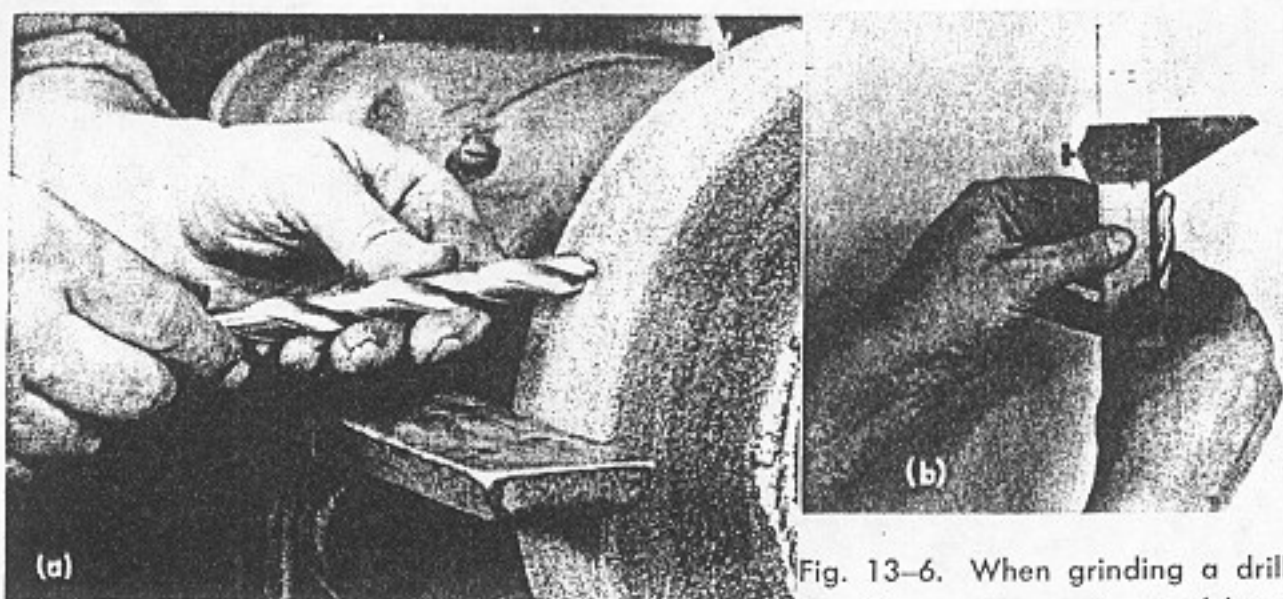
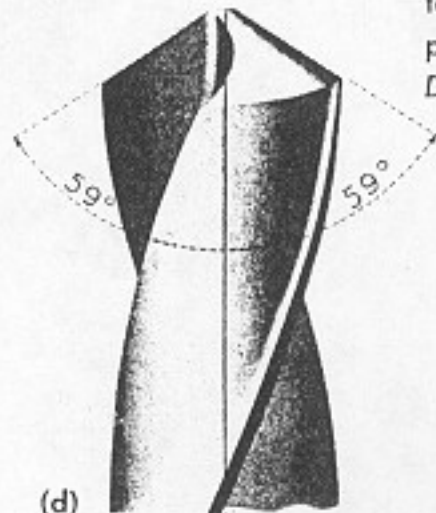
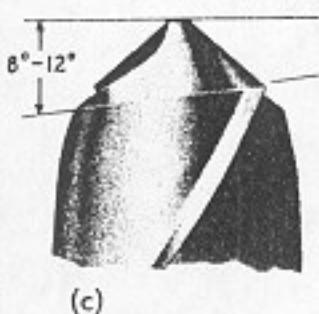


Fig. 13-6. When grinding a drill, exercise great care to avoid burning the point of the drill and to obtain the correct angles on the drill point. (Courtesy Cleveland Twist Drill Co.)



this time do *not* grind much metal off the drill; just polish up the point, while trying to keep the same shape as the point had when you started. Check your work several times with a drill sharpening gage (see Fig. 13-6b). Remember that the correct lip clearance is 12 to 15 degrees (see Fig. 13-6c), that the proper lip angle is 59 degrees (see Fig. 13-6d), and that both cutting lips must be the same length. Do not become discouraged, for it takes practice to be able to sharpen a drill properly.

Once you have sharpened the drill correctly, try it on a piece of metal. If it drills easily and cleanly, you have done a good job of drill grinding.

Drill Chuck. A drill chuck (see Fig. 13-7) is made to hold straight shank drills. It generally has three jaws, which are tightened onto the shank of the drill by turning of a key, which is not a part of the chuck. Be certain that this key has been removed before starting the drill.

Adapters for Taper Shank Drills. Taper sleeves (see Fig. 13-8) build up or increase the size of a taper shank drill or drill chuck. The tapered shanks on drills and chucks are generally Morse standard tapers. Morse standard taper sizes are numbered from 0 to 7. To increase the taper shank on a drill from a number 2 taper shank to a number 3 taper shank, a taper sleeve with a number 2 taper on the inside and a number 3 taper on the outside is used.

Machine Countersink. Countersinking with a machine countersink (see Fig. 13-9) involves making a 60-degree chamfer around the inside edge of a drilled hole (see Fig. 13-10). Because the countersink cuts as it revolves, it can be used in a drill press. In use, the countersink should be run at a slow speed.

Using a Machine Countersink to Countersink a Hole. To countersink a hole, first select a countersink of the proper size and place it in a drill chuck. Next, hold work to be countersunk in

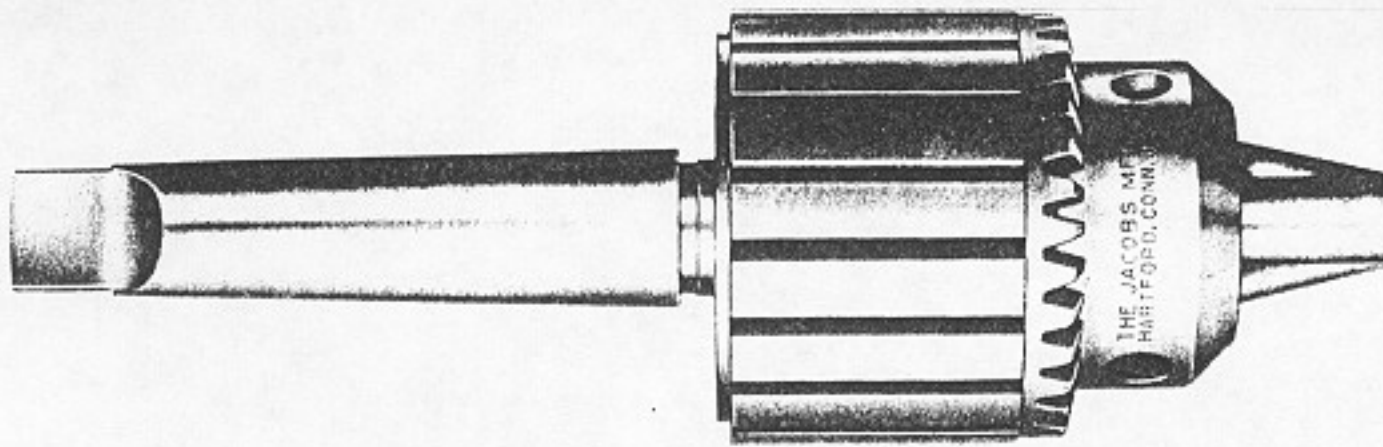


Fig. 13-7. In use, the taper shank of the drill chuck is inserted into the tapered socket of the drill press or lathe. (Courtesy Jacobs Mfg. Co.)

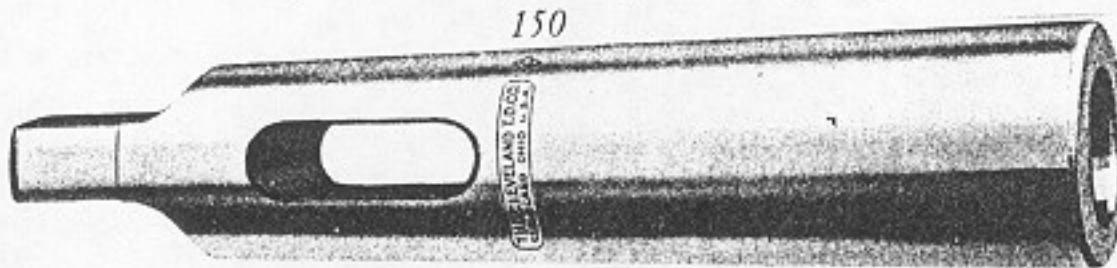


Fig. 13-8. Drill sleeve adapters for Morse taper shank drills or taper sleeves are used when it is necessary to increase the size of the taper of a taper shank drill. (Courtesy Cleveland Twist Drill Co.)

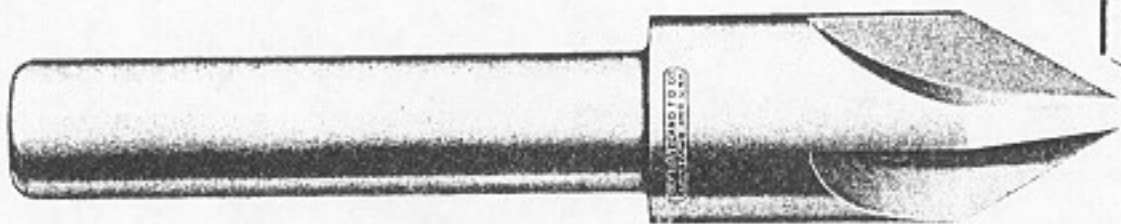


Fig. 13-9. Machine Countersink. (Courtesy Cleveland Twist Drill Co.)

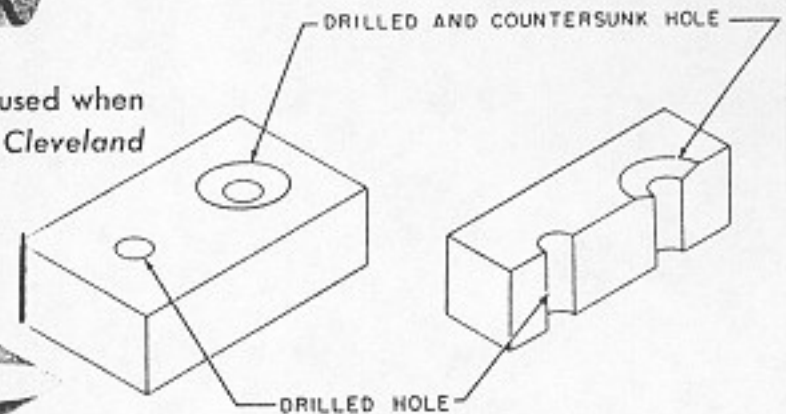


Fig. 13-10. Holes are generally countersunk to fit the heads of rivets, screws, or bolts.

a drill press vise or on the drill press table. Align the countersink with the drilled hole and clamp the drill press vise or work to the drill press table. Adjust the drill press to run at a slow speed and countersink the hole by applying just enough pressure to keep the countersink cutting. Stop countersinking when the hole is countersunk to the correct depth.

Drift Keys. Drift keys are wedge shaped (see Fig. 13-11) and are used to remove the tapered shank drills or drill chucks from a tapered socket. Drift keys are made in 8 different sizes, sizes 0 to 7, size 0 being the smallest.

Center Punch. The center punch is flat on one end and sharpened to a 90-degree point on the other end (see

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Fig. 13-12). It is usually used in marking the center location for drilling a

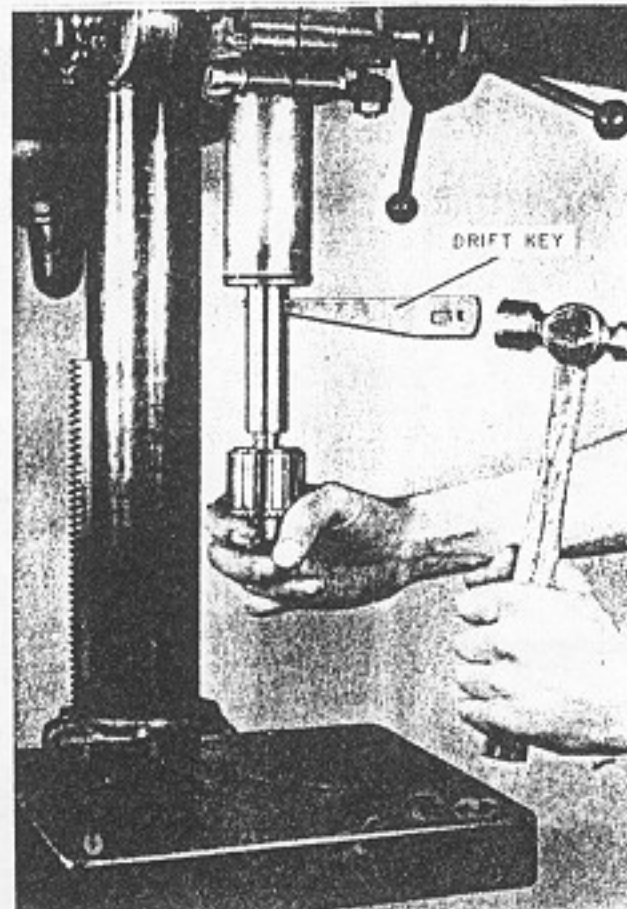


Fig. 13-11. Hold onto the drill chuck to prevent it from falling onto the drill press table.

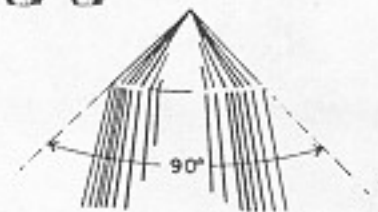
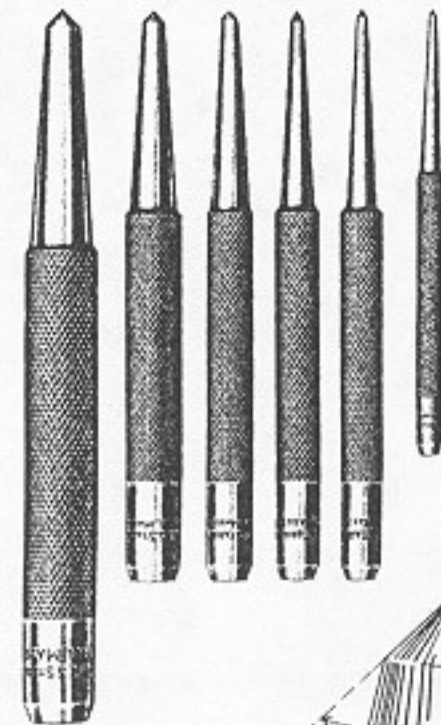


Fig. 13-12. Center punches are made in different sizes, as small drills require a small center punch mark and large drills a large center punch mark. (Courtesy L. S. Starrett Co.)

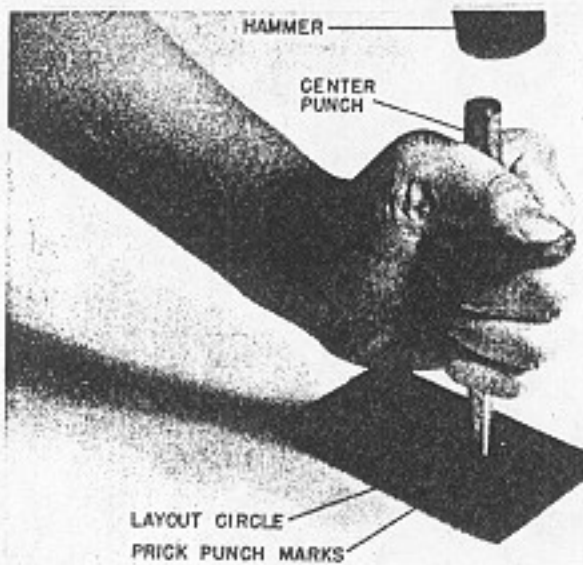


Fig. 13-13. The center punch should be held perfectly straight up and down while you are center punching the location for drilling a hole.

hole.

Using a Center Punch to Make an Indentation at the Location for Drilling a Hole. Because the point of a drill is not very sharp, it has a tendency to wobble on a metal surface before starting to drill. To make sure that the point does not wobble, an indentation should be made in the metal with a center punch, right where you want to make the hole. To make this punch mark, hold the point of a center punch on the location for the hole (see Fig. 13-13). Strike the center punch a sharp blow with a hammer. This

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punch mark should be a little larger than the web at the point of the drill.

Drill Press. Drilling is a machining process for making new holes or for enlarging existing holes. The machine used for making or enlarging holes is called a drill press. The cutting tool used is a drill. It is held in the drill press and driven by it when cutting a hole. In addition to the drilling of holes, the drill press is used for reaming, counterboring, countersinking, and spot facing.

Study Fig. 13-14 and familiarize yourself with the parts of the drill press, trying to figure out what each part is for. You will notice that it has four main parts, the base, the column, the table, and the head.

The speed at which the drill runs

is controlled by step-cone pulleys on the motor and spindle. Placing the belt on the largest pulley of the motor step-cone pulley and the smallest pulley of the spindle step-cone pulley gives the fastest speed at which the drill press will run. To change speed, the machine should be stopped and the belt switched from one step-cone pulley to the other on both motor and spindle pulleys.

The work to be drilled should never

be held in the hands while the hole is being drilled. In studying Fig. 13-15, you will note that three safe methods of holding the work are shown.

Drilling Holes at a Drill Press. When drilling a hole with the drill press, select a drill of the correct size and place it in the drill press spindle or a chuck. Lower the drill and move

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the metal until the point of the drill fits into the center punch mark. Now clamp the metal to the drill press table as shown in Fig. 13-15. Regardless of how accurately the center punch mark and the point of the drill are lined up, there is always the possibility that the drill will start drilling off center. When the location of a hole must be very accurate, the hole size is scribed around the center location and light prick punch marks are made on this line (see Fig. 13-16a). The drill is then started and lowered onto the metal. A very shallow depression is drilled. The drill is raised and the edges of the cone depression are compared with the scribed and punched circle. This must be done before the drill is permitted to cut its full diameter. If the depression appears to be off center (see Fig. 13-16b), a round nose chisel is used to make a cut on the side toward which the drill is to be drawn.

Now take another light cut with the drill. Compare the cone depression and circle again. If needed, make another cut with the chisel. Continue until the drill cut is centered within the circle. The speed at which the drill should run is governed by its size. Remember that small drills should run at a higher rate of speed than large ones. This rate of speed is obtained by changing the belt on the drill press from one step on the pulley to another. Drill the hole by applying enough pressure on the drill so that a continuous flow of metal chips will be ejected from the hole. A cutting oil should be used when drilling iron or steel, but not when drilling cast iron.

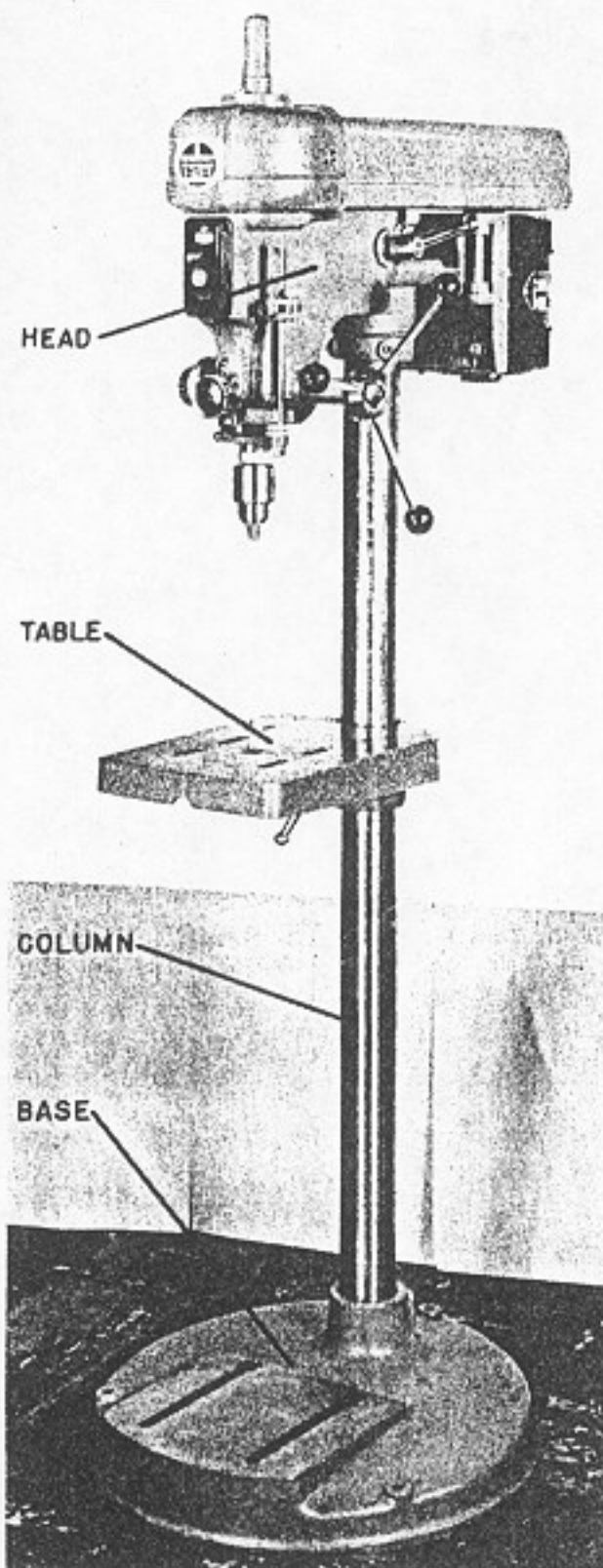


Fig. 13-14. Drill presses are made for both small and heavy work. The small table, or floor, model is used in most general metal shops. (Courtesy Walker-Turner.)

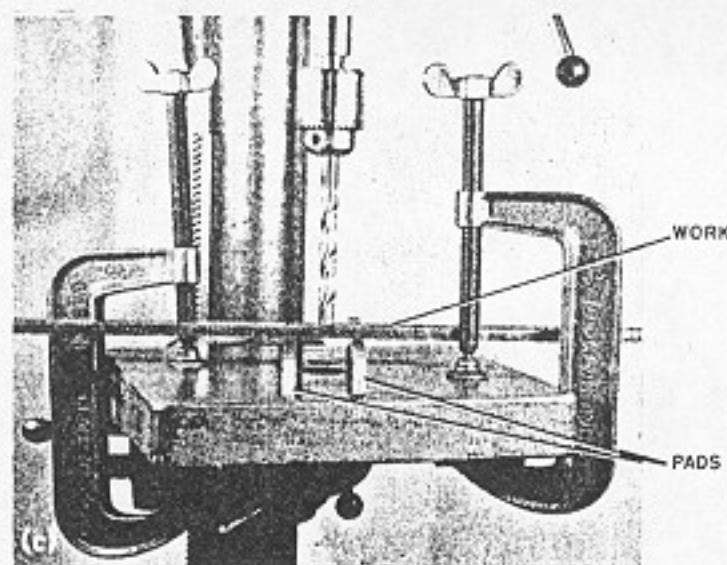
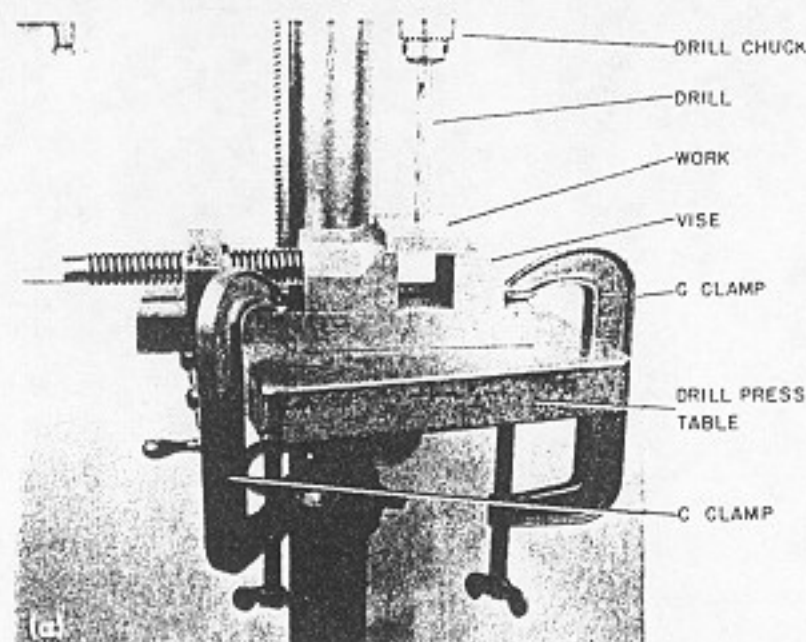


Fig. 13-15. The metal must always be held securely to the drill press table.

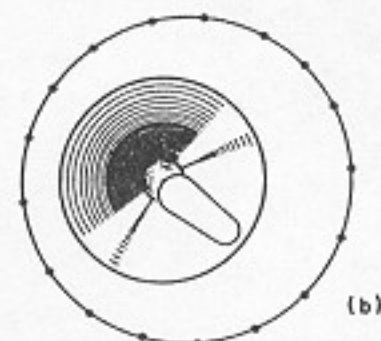
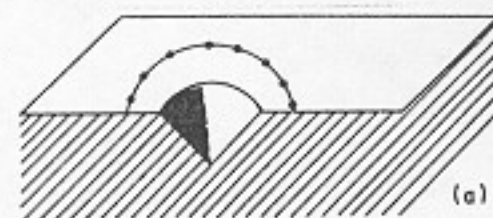
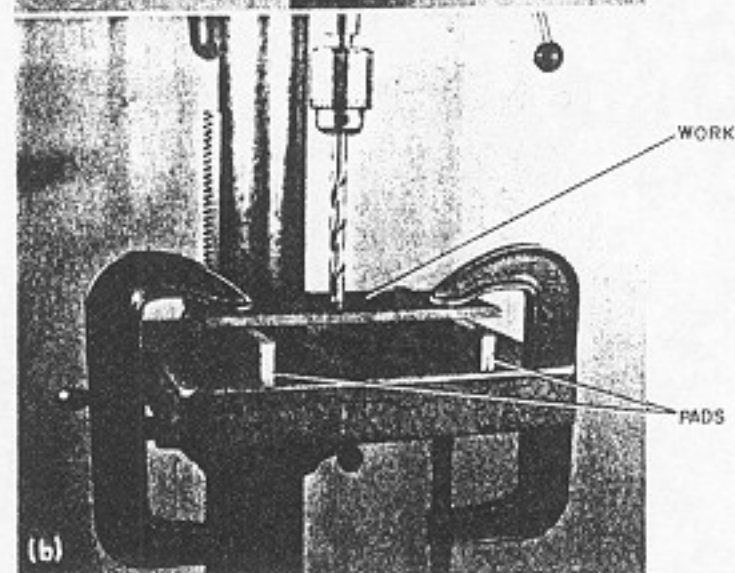


Fig. 13-16. Drilled holes that have started off center can be drawn back on center through careful use of the round nose cold chisel and the drill press.

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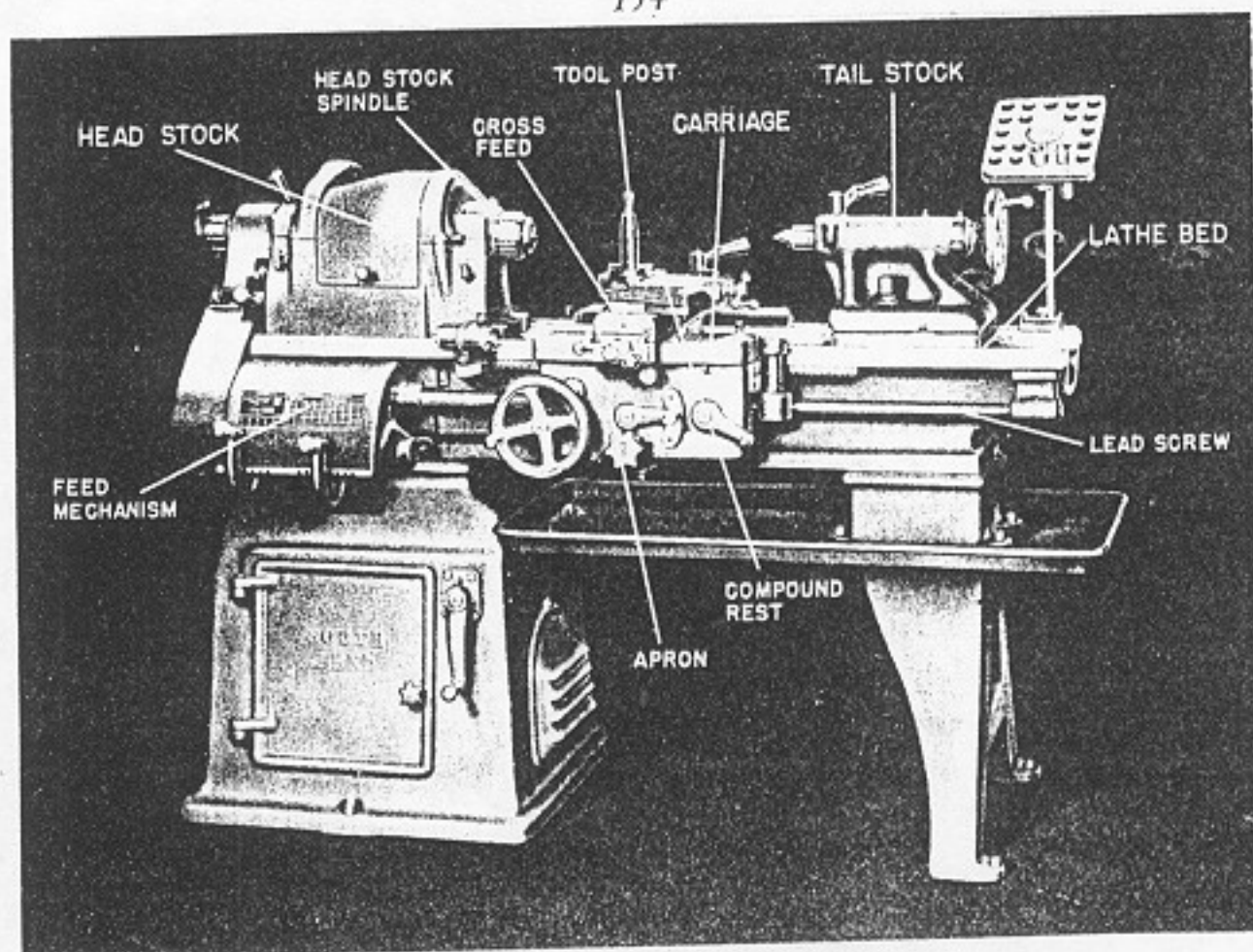
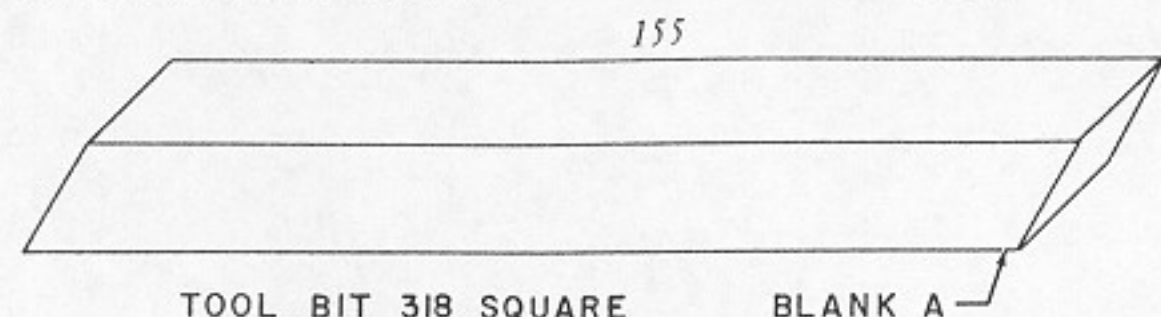


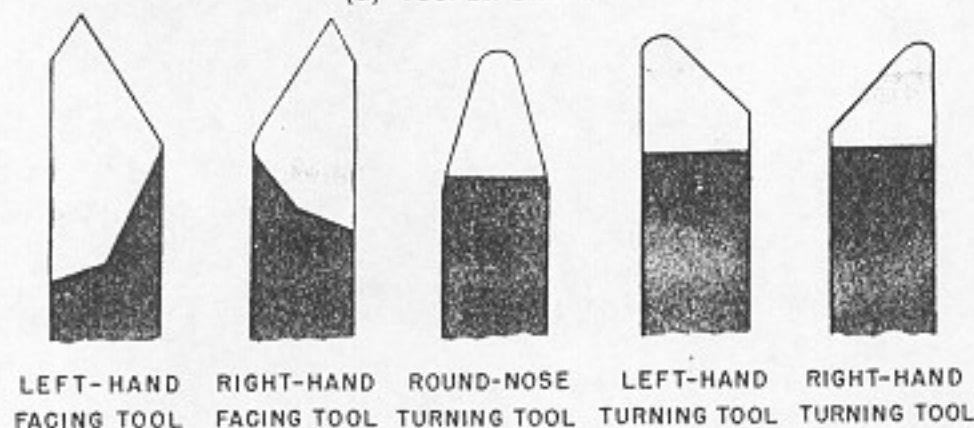
Fig. 13-17. Engine Lathe. (Courtesy South Bend Lathe Works.)

Engine Lathe

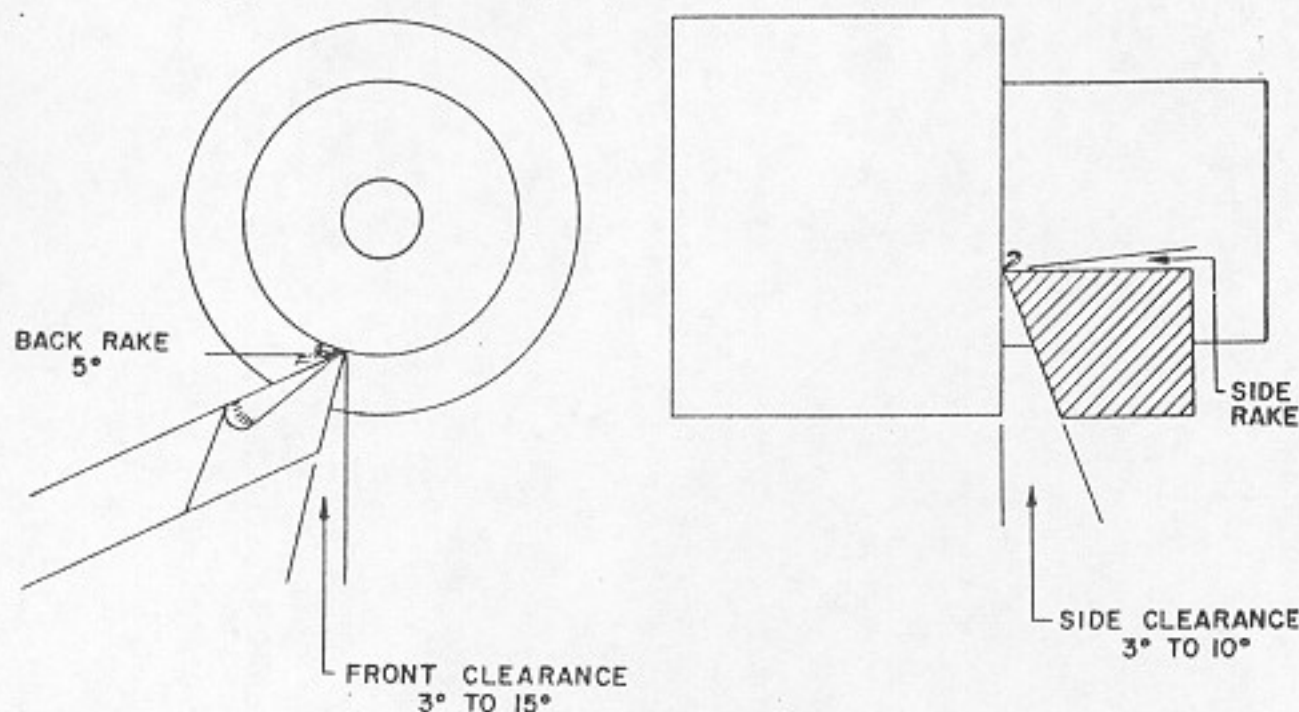
The engine lathe is a machine used to turn metal objects that are cylindrical in shape. It may be said that it is the father of all machine tools. Indeed, it would be most difficult to build other machines without it. It is possible to produce a larger variety of work with a lathe than with most of the other machine tools. It is usually powered by an electric motor. Some lathes have automatic feeds, a varied selection of speeds, and can be used to cut threads. The metal being turned is held between centers in a chuck or on the face plate. Although the lathe (see Fig. 13-17) as we know it today is far different from the tree lathe of two hundred years ago, funda-



(a) Tool bit blank.

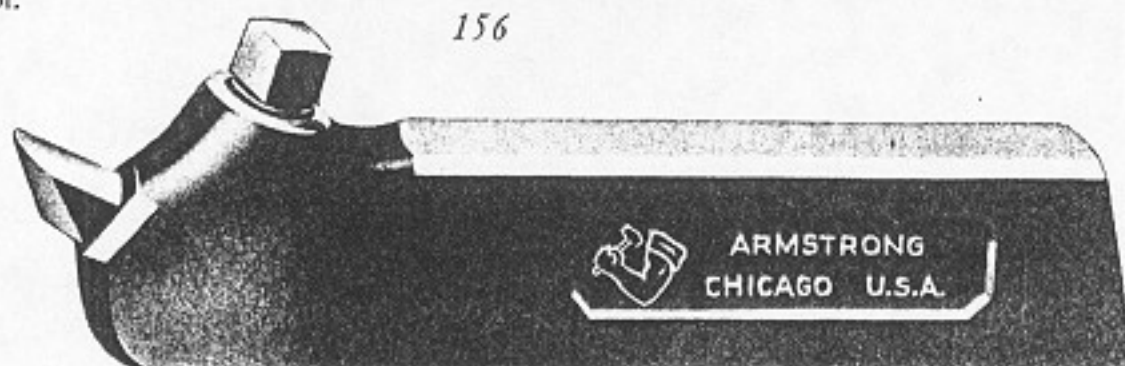


(b) Common tool bit shapes. (Courtesy Armstrong Bros. Tool Co.)

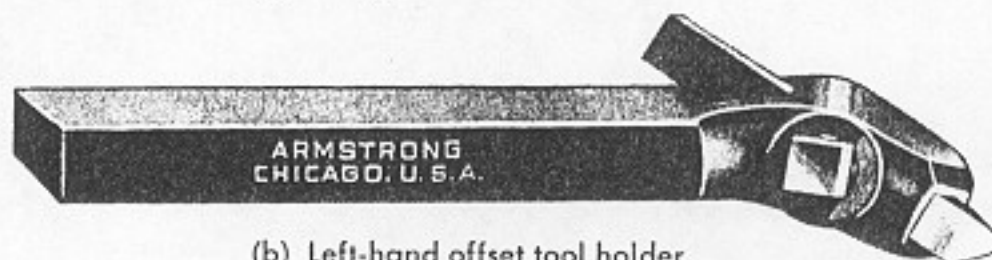


(c) Cutting rake and clearance.

Fig. 13-18. The grinding of a tool bit is very important, as the final results of turning depend on this tool.



(a) Straight shank tool holder.



(b) Left-hand offset tool holder.

mentally it performs the same purpose as the original machine.

The major parts of an engine lathe are the bed, the headstock, the carriage, and the tailstock. Study Fig. 13-17 carefully and learn to identify these parts.

The headstock assembly contains the pulleys and gears that revolve the spindle. It is the spindle (see Fig. 13-17a) that in turn revolves the work in the lathe. The carriage is an assembly of several parts: an apron, *b*, the cross feed, *c*, the compound rest, *d*, and the tool post, *e*, which holds the cutting

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tool. The cutting tool is fed along the work by the lead screw, *f*, which revolves as the lathe is operated. The gears in the feed mechanism, *g*, may be set to control the forward movement of the cutting tool along the piece being turned. The tailstock can be moved along the ways to fit the length of the piece being turned.

Tool Bits. The tool bit must be harder than the material it is to cut. For that reason, cutting tools or tool bits for lathe turning are made of high carbon steel, high speed steel or tungsten carbide steel. Each of these metals can be made harder than the metal being turned.

Grinding a Tool Bit. The end of a tool bit blank (see Fig. 13-18a) must be ground before it can be used to cut metal.

The more common cutting shapes ground on tool bits are the round nose, right-hand turning, left-hand turning, right-hand facing, and the left-hand facing tool (Fig. 13-18b). The round nose tool bit can be ground with a cutting edge on either side of the round nose, and may be used for either right- or left-hand turning. The right-hand turning and facing tool cuts on the left-hand side of the tool. The left-hand turning and facing tool cuts on the right-hand side of the tool. As indicated by their names, the turning tools are used to turn outside diameters. Facing tools are used to true up



(c) Right-hand offset tool holder.

Fig. 13-19. The selection of the tool holder depends on the work being turned. (Courtesy Armstrong Brothers Tool Co.)

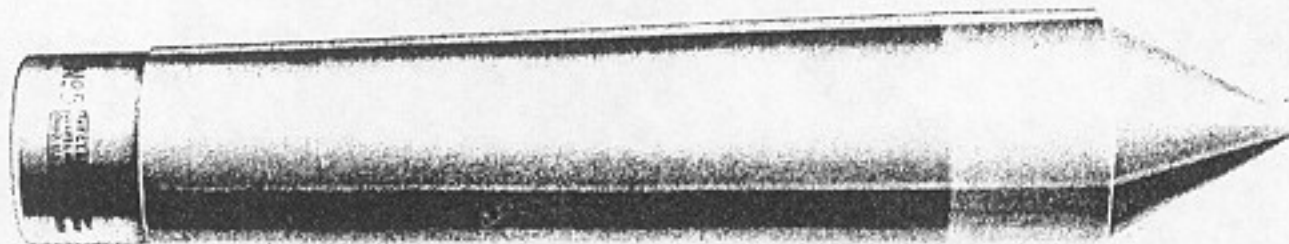


Fig. 13-20. The dead center is hardened. The 60° angle point must be ground on this center. The live center is soft, and therefore can be turned in the lathe. (Courtesy Cleveland Twist Drill Co.)

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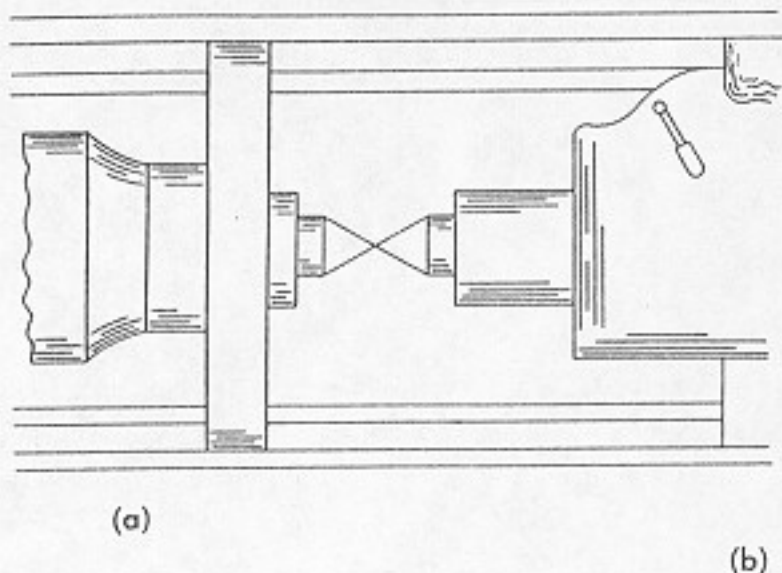
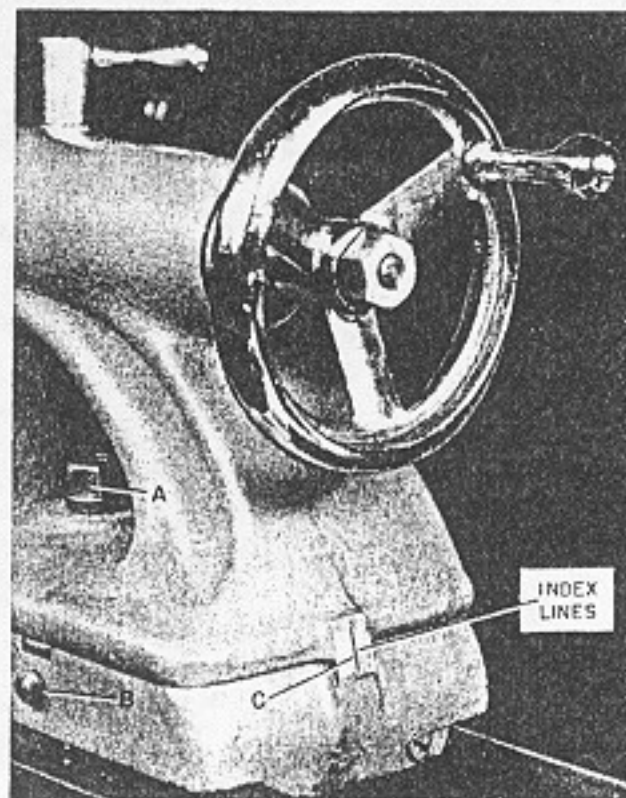


Fig. 13-21. When you use the center point method of alignment, the points of the centers should be sharp, not blunt.



flat surfaces, such as the ends of the metal being worked on.

All tool bits must be ground so that only the sharp cutting edge contacts the metal being turned. Therefore, tool bits are ground with back rake, side rake, side clearance and front clearance (see Fig. 13-18c).

Tool Holders. Tool holders are designed to hold a square shaped bit. They are made in various forms, namely, the straight shank, and the left- or right-hand offset (see Fig. 13-19).

Lathe Centers. Metal being turned in a lathe is revolved between two centers (see Fig. 13-20). The center used in the tapered socket of the headstock spindle revolves as the lathe is run. Therefore, it is known as the live center.

The center used in the tapered socket of the tailstock spindle does not revolve and is known as the dead center. This center, which is always hardened, serves as the bearing upon which one end of the metal revolves while it is being turned.

Aligning Lathe Centers. Lathe centers are in alignment when the points of the two centers touch each other (see Fig. 13-21a). If they do not line up point to point, the work being turned will be smaller at one end than at the other. This is known as a taper. To make a straight turned piece, you must always make certain that the centers are in alignment before placing work between them. To check the alignment of centers, use either one of the following methods (see Fig. 13-21a): The first method is to have both center points touching. The second method is for the index lines located on the back of the tailstock below the hand wheel touching each other as in Fig. 13-21b. To align the centers by the first method, first loosen the tailstock clamping nut, *a* (Fig. 13-21b),

and move the tailstock toward the headstock until the point of the dead center almost touches the point of the live center. If the points of the centers touch, they are in alignment. If they are out of alignment, however, and the dead center should be moved to the right, screw in the right set-over screw, *b*, and screw out the left set-over screw. Do just the opposite, to move the center to the left. Then tighten both set-over screws and again check the alignment of the centers. In the second method, line up the graduation

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marks on the back of the tailstock, *c*; this is also done by adjusting the set-over screws.

Face Plate. The face plate (see Fig. 13-22) fastens to the headstock spindle, and turns as the lathe is run. It is generally made of cast iron and has holes or slots in it. These may be used to clamp metal to the face plate for turning or facing. They may also be used for driving the lathe dog.

Lathe Chucks. A chuck is a clamping or holding device used for holding work that cannot be held between the centers of a lathe. There are two kinds of chucks: the three-jaw Universal chuck (see Fig. 13-23a) and the four-jaw Independent chuck (Fig. 13-23b). When one tightens the Universal chuck, all three jaws move at the same time. For this reason, it is a self-centering chuck. The other chuck has

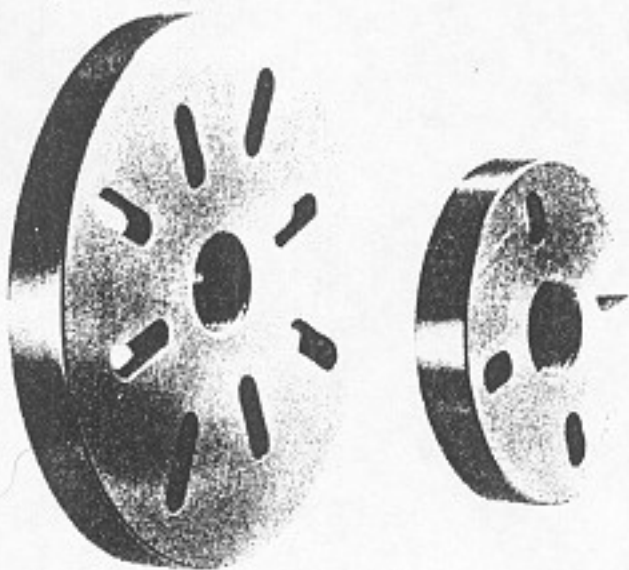
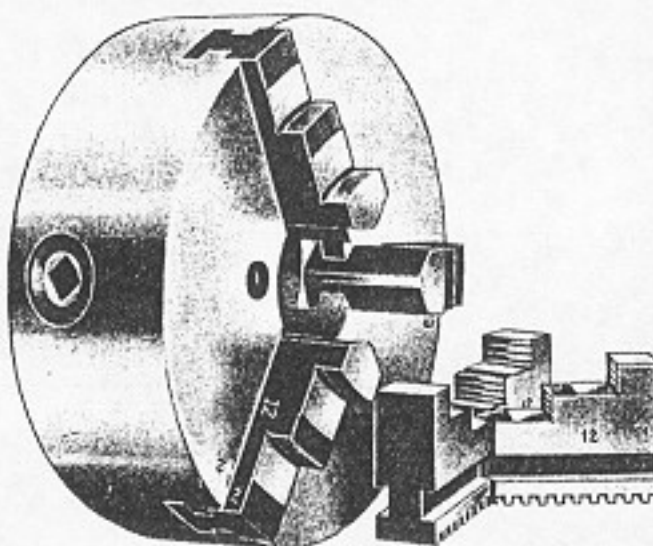


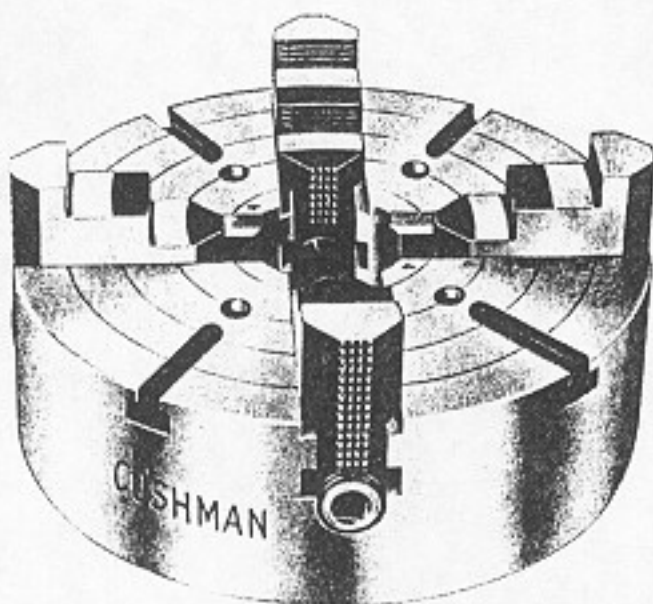
Fig. 13-22. Face Plates. (Courtesy South Bend Lathe Works.)

four jaws, each of which can be moved independently. For this reason, it is called the Independent chuck.

Tightening Metal in a Lathe Chuck. To move the jaws of the lathe chuck, first insert a lathe chuck wrench into the square socket on the side of the chuck. Open the jaws of the chuck by turning the wrench until the opening is larger than the diameter of the metal to be turned. Insert the metal into the chuck and turn the wrench in the op-



(a) Universal chuck.



(b) Independent chuck. (Courtesy Cushman Chuck Co.)

Fig. 13-23. Lathe Chucks.

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posite direction until the jaws tightly grip the metal.

Facing Work Held in a Chuck. Facing is the cutting or smoothing of the flat surfaces on the ends of bars of metal. This operation is commonly called radial facing. When facing work that is held in a chuck, either a round nose or a facing tool may be used. Set the cutting edge of the tool bit against the center of the face of the work. Advance the tool against the metal by moving the carriage along the ways toward the headstock. This will permit the tool bit to start cutting. Hold the carriage so it will not move, and turn the cross feed handle (see Fig. 13-17c) in a counterclockwise direction. The tool bit will now cut from the center of the metal and across the face to the outside edge (see Fig. 13-

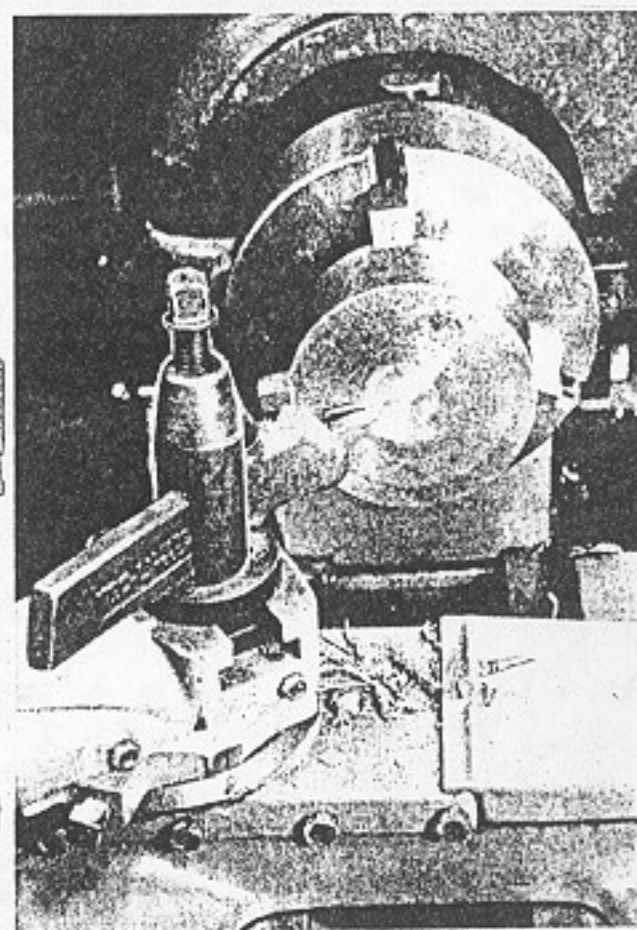


Fig. 13-24. In setting the tool, it may help to set it to the point of a center before the chuck is placed on the headstock spindle.

24). If a little bump is left right at the center, the tool bit was not set right on center. To remove this bump, set the tool bit to the center of the bump and take another cut across the face



Fig. 13-25. Combined Drill and Countersink. (Courtesy Cleveland Twist Drill Co.)

of the metal. If the face is now perfectly smooth, the end has been properly faced.

Combined Drill and Countersink. A combined drill and countersink (see Fig. 13-25) drills a hole and countersinks it at the same time. It is used to drill and countersink work centers in the ends of round bars before they are placed between the centers of a lathe.

Drilling Center Holes. Tapered holes must be drilled in both ends of a piece of metal before it can be placed between the centers of the lathe. These holes are drilled and countersunk with the combined drill and countersink.

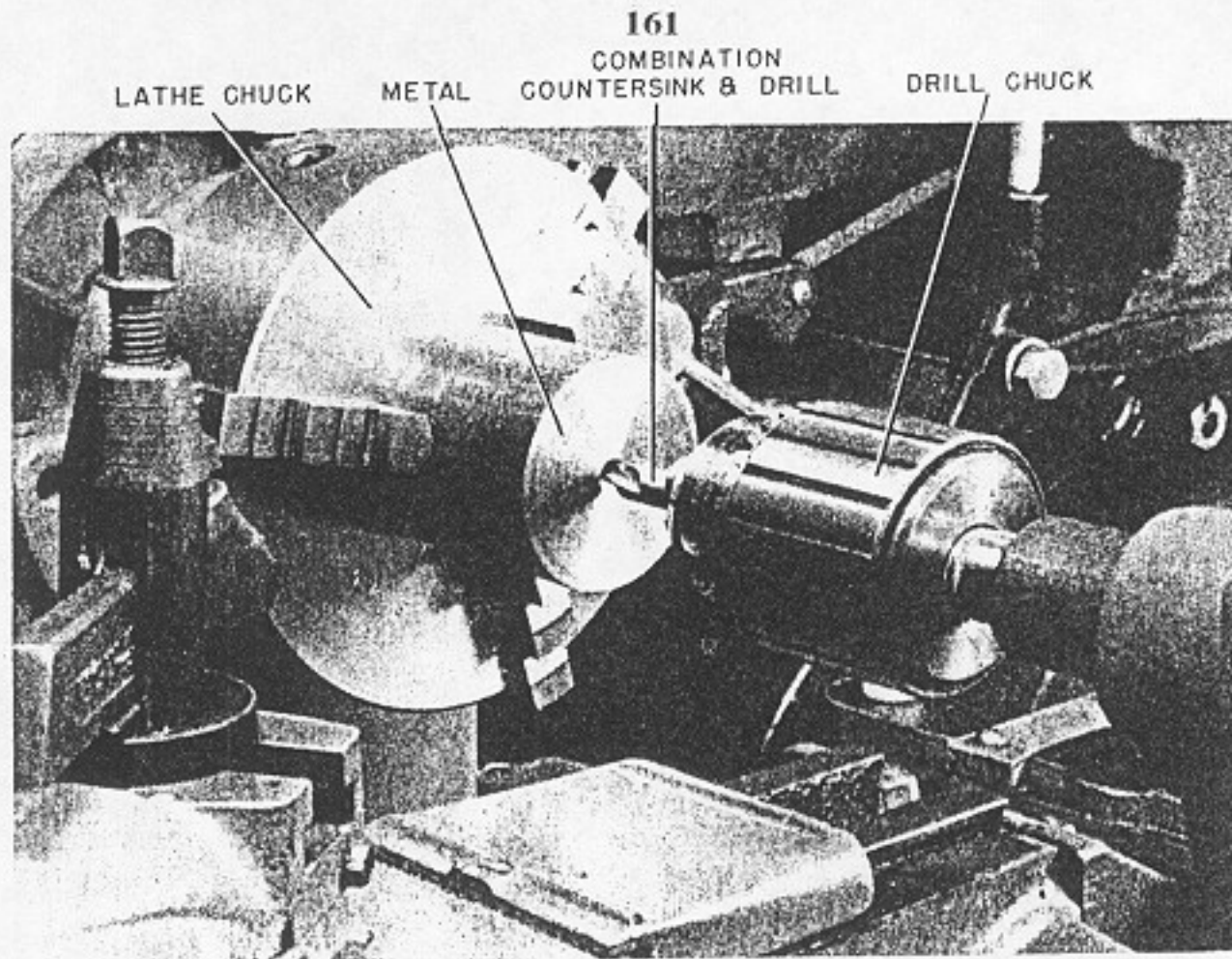


Fig. 13-26. The small drill on the end of a drill and countersink combined breaks easily. Always run the lathe at a fast speed when using this drill.

There are several methods of locating the center holes before drilling them. We shall consider only one, the drilling of center holes with a three-jaw Universal lathe chuck. The accurate drilling of these holes is very important and requires careful attention. The tailstock must be in perfect alignment and the metal which is held in a lathe chuck must be faced before work centers are made. Place the countersink and drill in a drill chuck and insert it in the tailstock spindle. Then, move the tailstock up until the point of the drill and countersink are within one inch or less of the metal (see Fig. 13-26). With the lathe running, advance the drill and countersink into the end of the metal until the center hole is drilled and reamed to the correct depth (see Fig. 13-27).

Lathe Dog. There are a number of different kinds of lathe dogs. However, the safety bent tail lathe dog, as shown in Fig. 13-28, is a good example, since it is widely used in school shops.

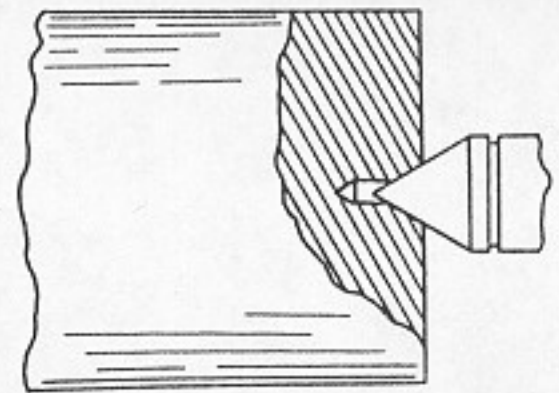
Fastening the Lathe Dog on the

Metal. The lathe dog is used to drive the work that is held between centers of the lathe. For this reason, it must be positioned close to the end of the work that is to be held on the live center and the screw tightened. The tail of the lathe dog is inserted into one of the slots of the face plate. The drive for turning the work comes from the face plate, as it turns the tail of the dog.

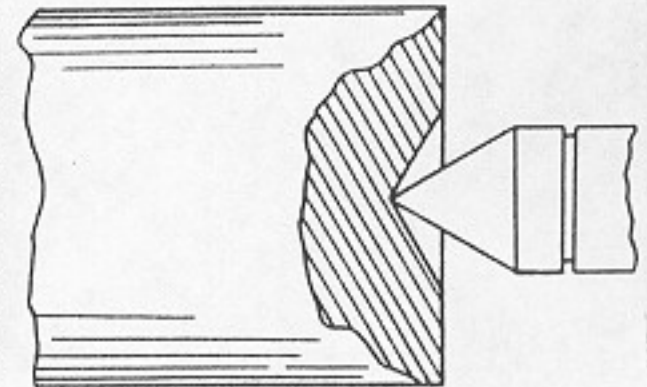
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Lathe Turning. Now that you have an understanding of some of the lathe accessories and of how to prepare a piece of metal for turning, you are ready to start to work. You can begin by mounting a piece of round stock 1" in diameter and 6" long in the lathe, and turning it to a finished diameter of $\frac{7}{8}$ ".

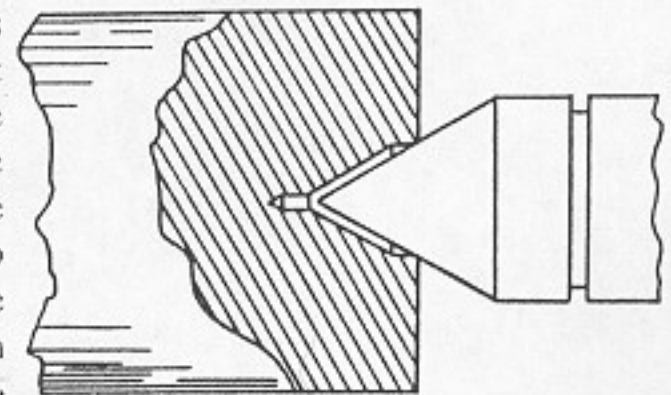
Mounting Work Between Centers. Start by drilling the center holes and clamping a lathe dog on one end of the metal, as shown in Fig. 13-29. You are now ready to place the work between centers. First lubricate the center hole that will be held by the



(a) Properly drilled and countersunk work center.



(b) Drilled too shallow and at wrong angle.



(c) Drilled and countersunk too deep.

Fig. 13-27. A rule-of-thumb method of estimating when the correct depth has been drilled is to use the depth of the drill plus about $\frac{3}{4}$ the length of the countersink.

dead center. Place the work on the live center with the tail of the lathe dog in a slot of the face plate. Next, move the tailstock along the bed of the lathe until the point of the dead center is close to the end of the metal. Tighten the tailstock clamping nut. Turn the tailstock hand wheel to run the dead center *d* into the center hole. Adjust the dead center so that the work turns freely but at the same time



Fig. 13-28. Lathe dogs are made in different sizes to fit stock of various diameters.

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is held in such a way that there is no end play between the centers *b* and *d*. When the work has been properly adjusted, no more than about two inches of the tailstock spindle *e* should be projecting from the tailstock.

Using the Point of a Lathe Center to Set the Tool Bit for Turning. To set the tool bit for turning, hold the cutting edge about $\frac{1}{64}$ " above the

point of the live center (see Fig. 13-30). Once the correct setting has been obtained, tighten the tool post screw. Check the setting a second time to make sure it has not changed during the tightening. When properly set it should appear when you look down on it as in Fig. 13-30a, and from the end, as in Fig. 13-30b.

Straight Turning. With the work between the centers and the tool bit properly set, you are ready to start straight turning. The amount of metal to come off before the finished size is reached should be removed with as few cuts as possible. These cuts are known as roughing cuts. They should remove metal as fast as possible down to within $\frac{1}{64}$ " or $\frac{1}{32}$ " of the finished diameter. The first roughing cut is

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started by moving the tool up to, but not touching, the end of the metal held by the dead center. Now start the lathe and, feeding by hand, take a cut that is about $\frac{1}{2}$ " in length and stop the lathe. Do not move the tool away from the metal; measure the diameter just cut with calipers or a micrometer. If the finished size has been reached, engage the feed and take a cut that is from $\frac{1}{2}$ to $\frac{3}{4}$ the length of the work, as shown by *b*,

Fig. 13-31a. Disengage the feed, but do not change the setting of the tool. Then, move the carriage and tool back to the dead center. If a second or third roughing cut is needed, repeat the operation until you are within $\frac{1}{64}$ " or $\frac{1}{32}$ " of the finished diameter. Remove the work from the lathe and clamp the lathe dog on the opposite end. Place the work back between the centers (see Fig. 13-31b). Start the lathe and engage the feed. Rough turn the end *a* to the same diameter as the other end, *b*. Now you are ready to take a finishing cut. Resharpen the tool before making this cut. Finishing cuts are made the same as roughing cuts except that a light, smooth cut is made with a slow feed. Great care should be used in checking the diameter when making the finishing cut, since work cut under size is useless and becomes scrap.

Turning a Shoulder. To turn a shoulder, place the work between centers or in the lathe chuck. Then, lay out and mark the location for the shoulder. With a turning tool, rough turn the metal to within $\frac{1}{64}$ " or $\frac{1}{32}$ " of the finished diameter. Stop the cut within $\frac{1}{32}$ " of the location for the shoulder (see Fig. 13-32a). Now make a finishing cut to the shoulder

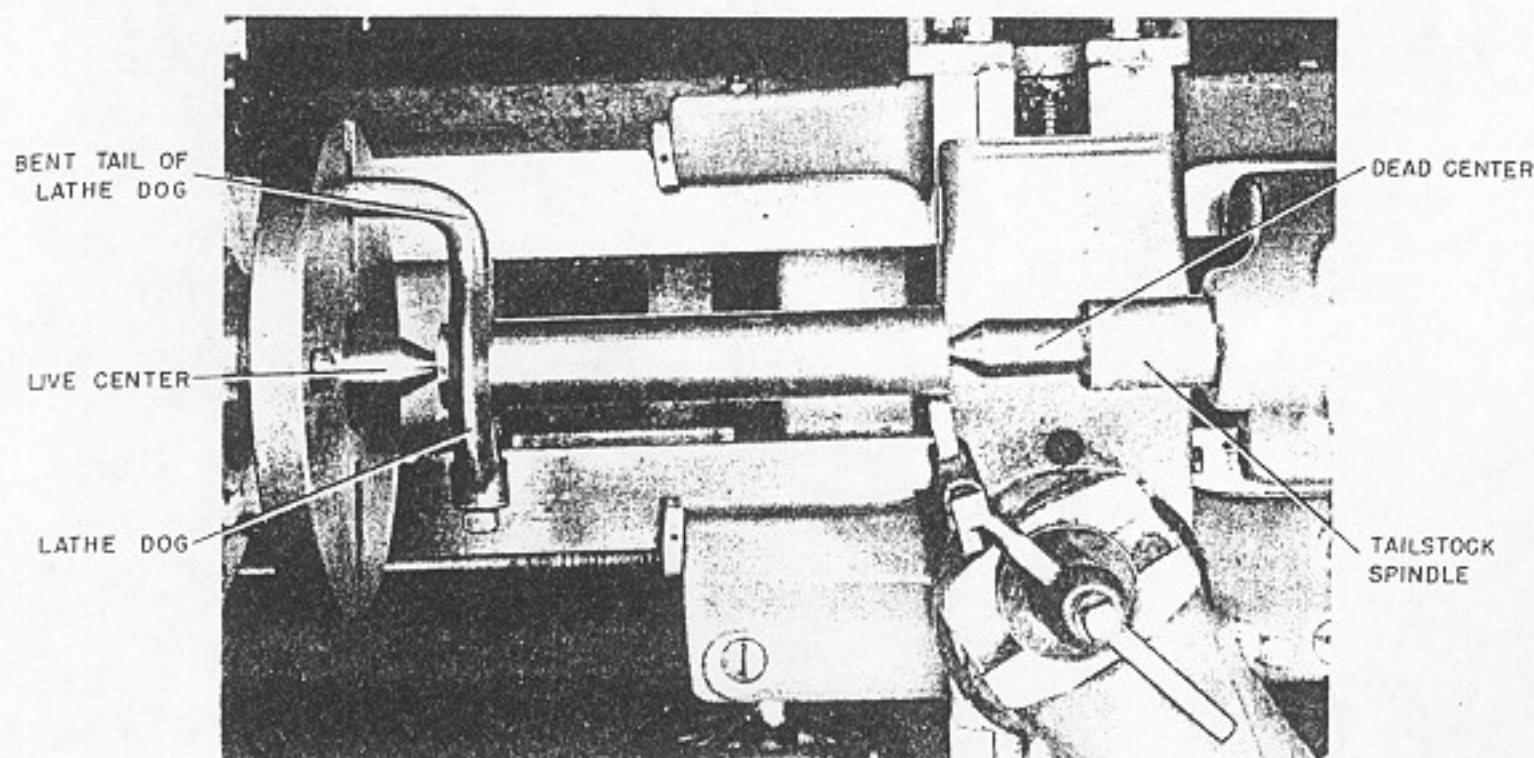


Fig. 13-29. When the dead center is adjusted too tightly, it will often cause the point of the dead center to wear or be twisted off.

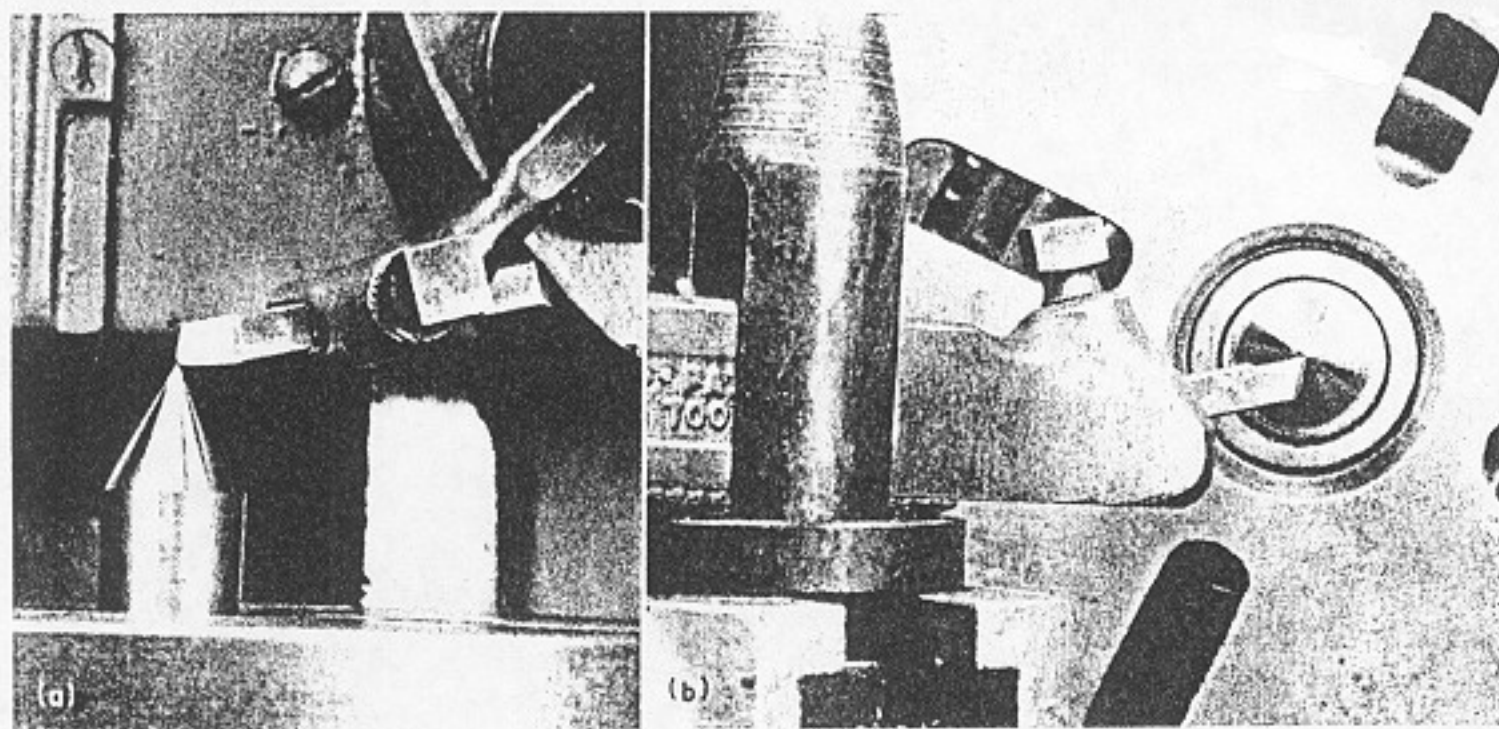


Fig. 13-30. If the tool bit is set too high, it does not cut. If set too low, it scrapes the metal instead of cutting it.

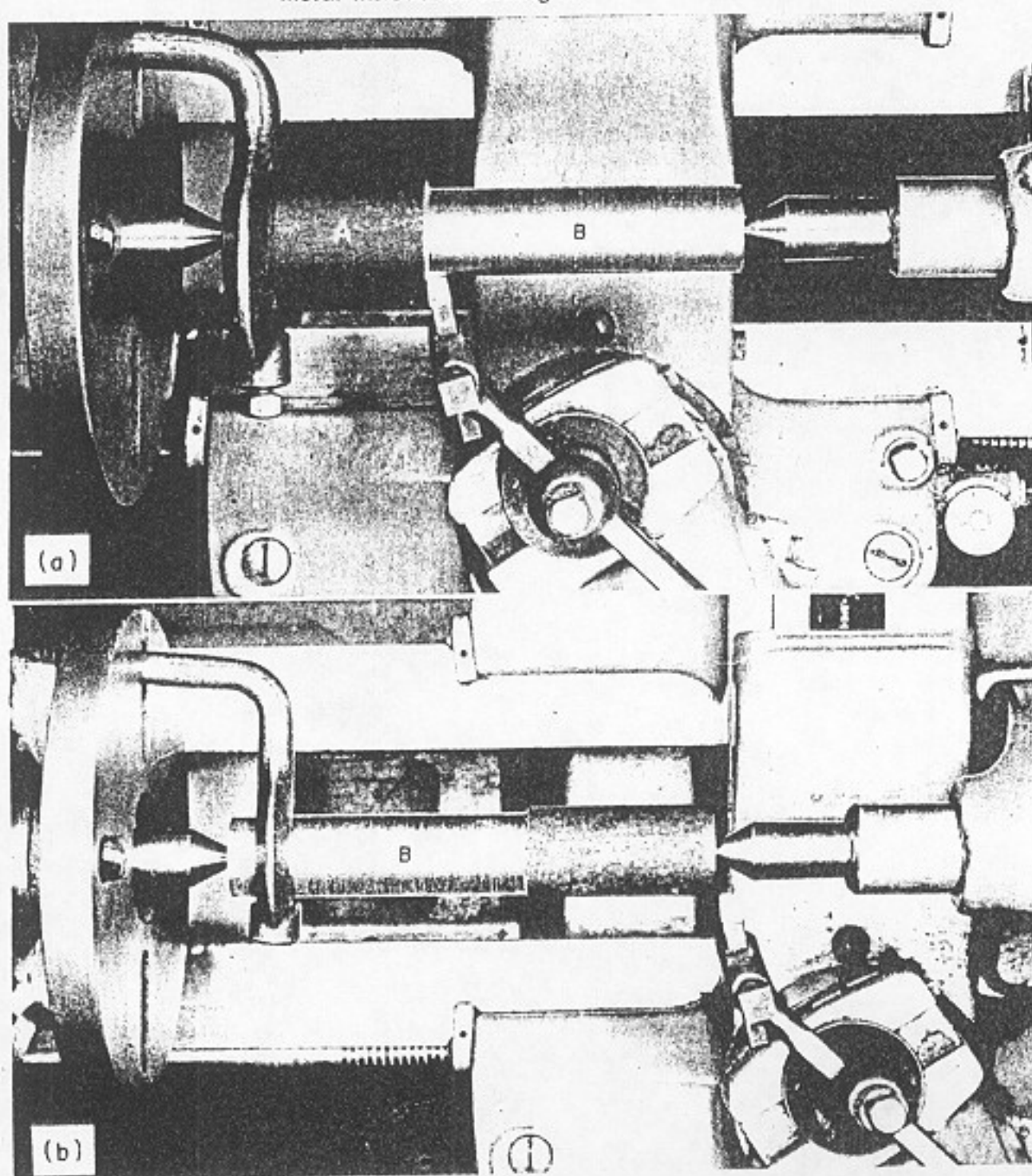


Fig. 13-31. As few roughing cuts as possible should be made to reduce the metal down to the size for a finishing cut.

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location. Replace the turning tool with a facing tool and set the point of the tool slightly ahead of its side (see Fig. 13-32b). Carefully set the point of the facing tool to the diameter just turned, and move the carriage by hand toward the shoulder. The point of the facing tool will remove the radius left by the round nose of the turning tool.

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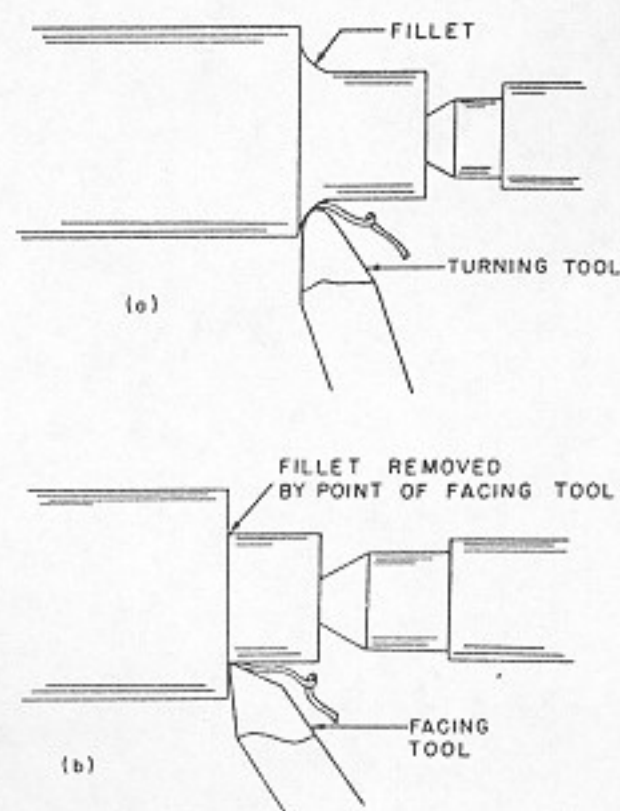


Fig. 13-32. When removing the radius with the facing tool, be careful that you do not cut deeper at the shoulder than the finish diameter.

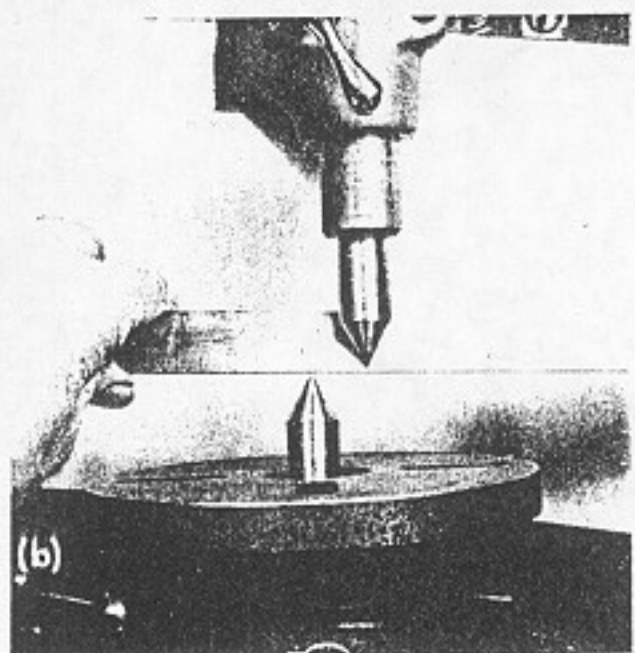
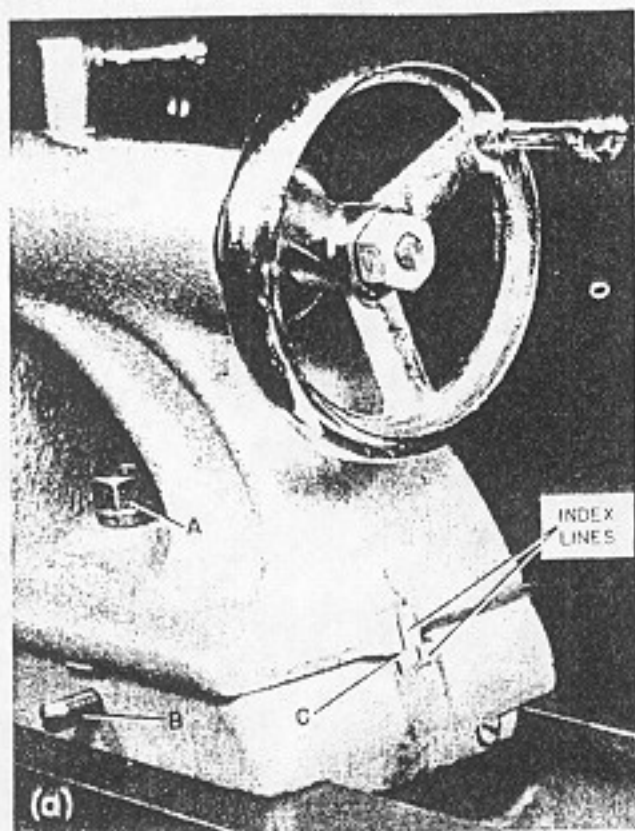


Fig. 13-33. The tailstock center should be offset toward the front of the lathe for turning most tapers.

Now engage the cross feed mechanism so that the tool will be backed out and away from the finished diameter facing the shoulder. Often more than one facing cut may be necessary to remove the radius and face the shoulder to its proper location.

Taper Turning. Taper turning means cutting the metal so that it gradually becomes smaller and smaller from one end to the other. The point of a pencil is tapered; starting from the size of the pencil, it gradually becomes smaller and smaller until it becomes a point. This gradual decreasing in diameter makes the taper.

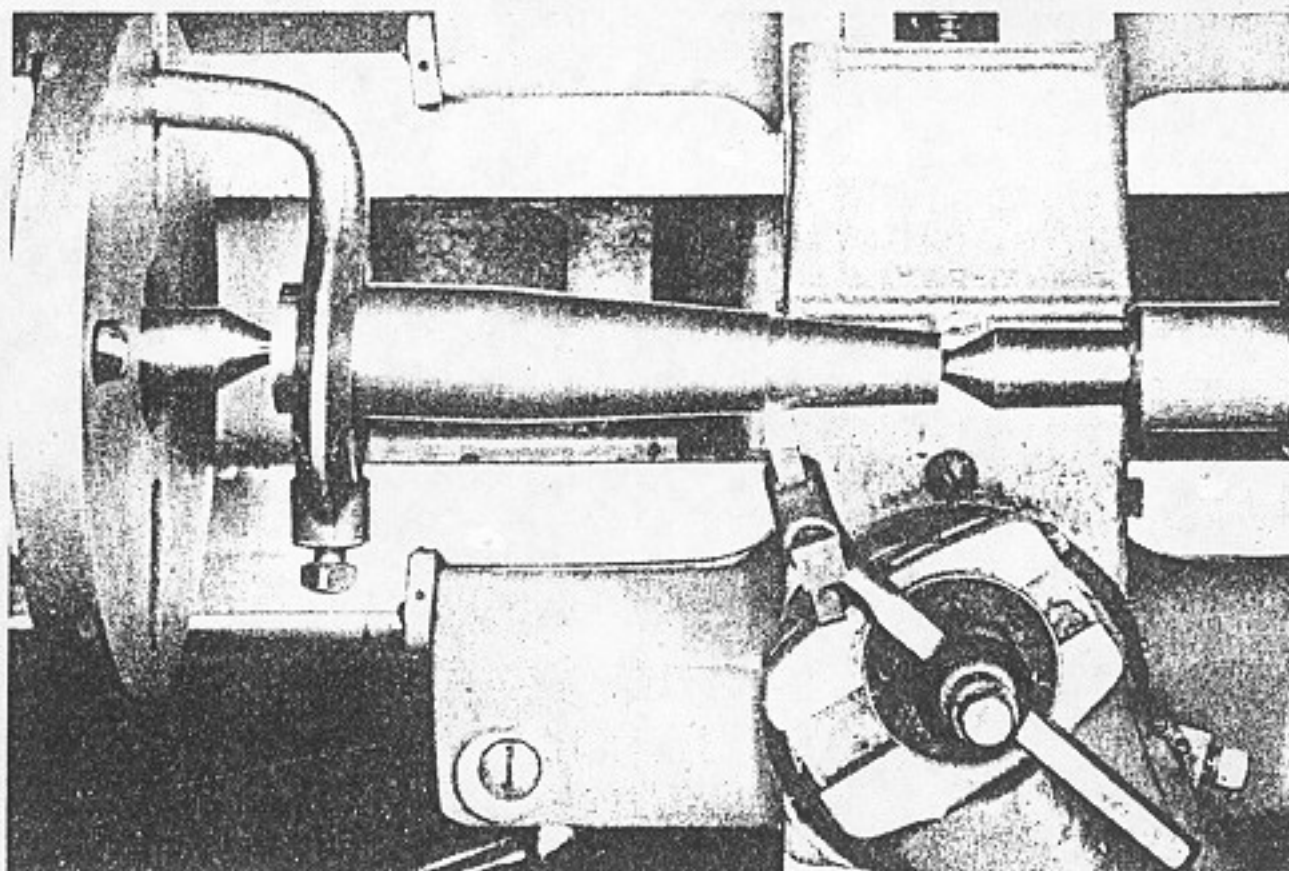


Fig. 13-34. If the tailstock set-over has been done accurately, the taper will be cut to the correct size.

To cut a taper, we must first know the amount of diameter, expressed in inches, that the metal should decrease in size for each inch or foot of its length. The taper per foot is found by multiplying the amount of taper

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per inch by 12. If the taper is $\frac{1}{8}$ " per inch, it will be $12 \times \frac{1}{8}$ " or $1\frac{1}{2}$ " of taper per foot. In some cases we know the taper per foot, but not the taper per inch. When this is the case, the taper per foot is changed to taper per inch by dividing by 12. For example, a taper of $1\frac{1}{2}$ " per foot divided by 12 equals $\frac{1}{8}$ " of taper per inch. Tapers may be cut in several different ways. Only two methods will be considered here. The first method is the tailstock set-over method and the second method is setting the compound rest at an angle.

Tailstock Set-Over Method. To turn a taper by setting over the tailstock, first figure the amount the tailstock is to be moved to the right or left by the following rule: *Divide the taper in inches per foot by 12 to reduce the taper to inches per inch. Then multiply by the total length of the*

piece in inches and divide by 2. The quotient will be the set-over of the tailstock.

Two methods may be used to measure the amount of tailstock set-over. The first method is to measure the distance between the index lines (c, Fig. 13-33a) on the back of the tailstock. The second method is to measure the distance between the two points of the live and dead centers (Fig. 13-33b).

After calculating the amount of set-over, loosen the tailstock clamp nut a.

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To move the center to the right, loosen the set-over screw on the back of the tailstock and screw in the front set-over screw b. With a rule or dividers, measure the amount of offset between the graduation marks on the end of the tailstock (c, Fig. 13-33a). Or, with a rule, measure the amount the two center points a and b are out of alignment (Fig. 13-33b). Tighten both set-over screws and check the offset again. The tool bit should be set for straight turning. Now clamp the lathe dog on one end of the metal and place it between the lathe centers (see Fig. 13-34). The taper is cut by using the same procedure as in straight turning.

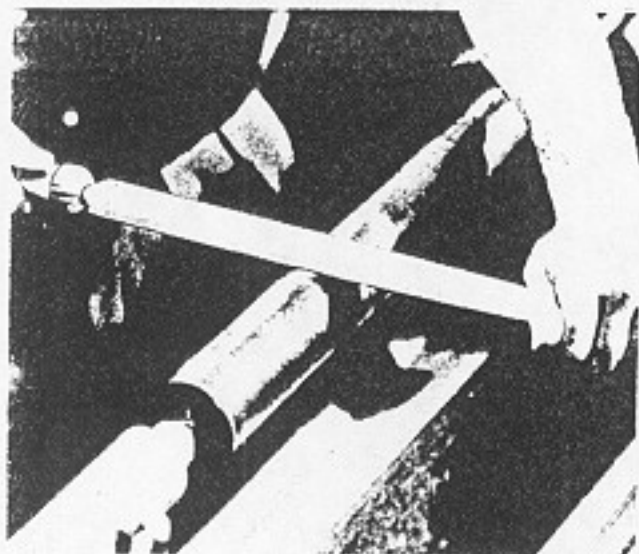


Fig. 13-35. A file handle should always be used in filing at a lathe. (Courtesy Nicholson File Co.)

Setting Compound Rest at an Angle. The compound rest is used to cut short, abrupt tapers like the 60-degree points of lathe centers. To do this, determine the angle to which the compound rest is to be set. Then loosen the two nuts or screws that are located at the base of the compound rest. Slowly turn the compound, while reading on the graduated base. When you have obtained the desired angle, lock the compound by tightening the two nuts or screws. Then set the cutting edge of the tool bit for turning and cut the taper by turning the hand crank of the compound rest.

Filing at a Lathe. To file at the

lathe, grasp the handle of the file in one hand and the point of the file with the thumb and fingers of the other hand. The point of the file is held ahead and to the right so that the file is at an angle to the work (see Fig. 13-35). Push the file lightly across the revolving metal. Each stroke of the file should overlap the previous one. Make as few strokes as possible. Too much filing at a lathe will cause the work to be undersized, tapered or irregular of surface. Clean the file often; this is very important. A mill or lathe cut file is used when filing at a lathe.

Using Emery Cloth to Polish a Turned Surface. To use emery cloth for polishing, the turned surface must first be filed. With the lathe running at a high speed wrap a piece of fine emery cloth around the metal and hold it with the fingers of one hand, while slowly moving the emery cloth back and forth over the surface of the metal. After the cloth has become worn, apply a few drops of oil to the metal. Continue polishing for a few minutes and then turn the cloth side against the work. The action of the oil and worn emery against the cloth will produce a high polish.

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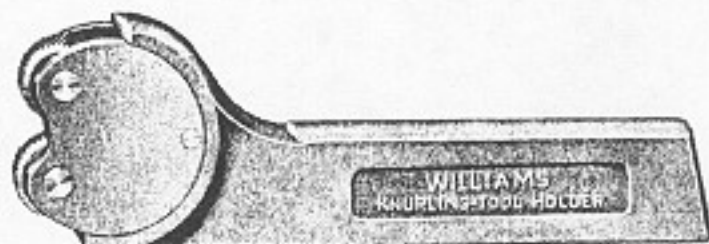
Knurling Tools. There are two types of knurling tools. One holds three sets of knurls in a revolving head (see Fig. 13-36a), and the other holds one set of knurls in a self-adjusting head (see Fig. 36b). The knurling tool is used to make a rough surface for gripping or for an ornamental effect on work that has been turned in a lathe.

Knurling. No metal is removed during the knurling process; the surface is roughened when the hardened knurls are pressed into the revolving metal (see Fig. 13-37). To knurl, first select a knurling tool and place it in the tool post. Then adjust the knurling tool to the center of the work with the knurls parallel to the surface to be knurled. Set the lathe to run at a slow speed and force the knurls into the work. After doing this, start the lathe and engage the automatic feed mechanism. Apply oil liberally. Knurl the desired distance. If the knurled surface is not fully formed, force the knurls deeper into the metal and knurl a second time.

Using a Twist Drill to Drill Holes at a Lathe. To drill a hole at the lathe, place the work to be held in a chuck and face the end to be drilled. The tailstock must be in per-



(a) Revolving head knurling tool.



(b) Self-centering knurling tool.

Fig. 13-36. Knurling Tools. (Courtesy J. H. Williams & Co.)

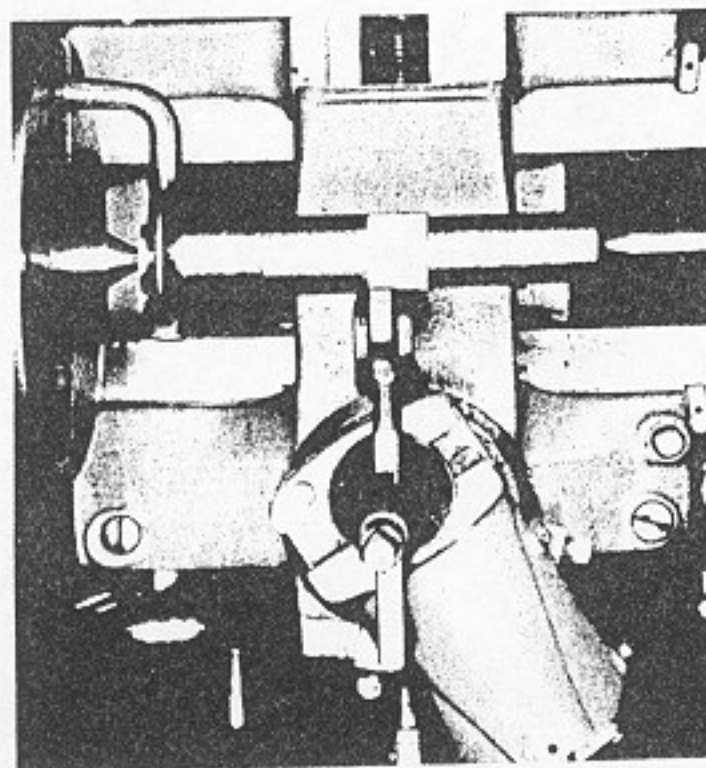


Fig. 13-37. In knurling, both the speed and the feed of the tool along the work should be slow.

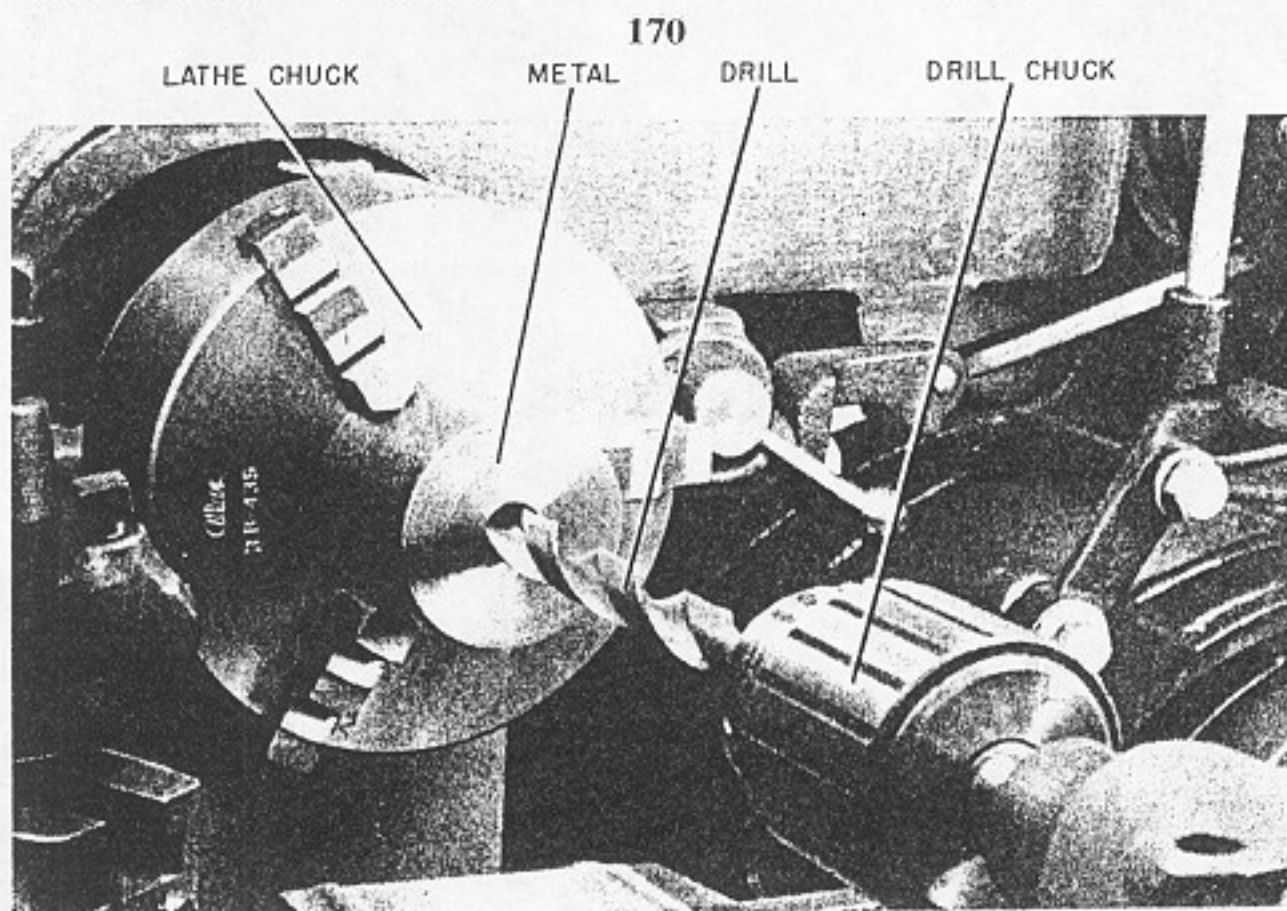


Fig. 13-38. This method of drilling makes possible the drilling of a hole in the exact center of a round piece of metal.

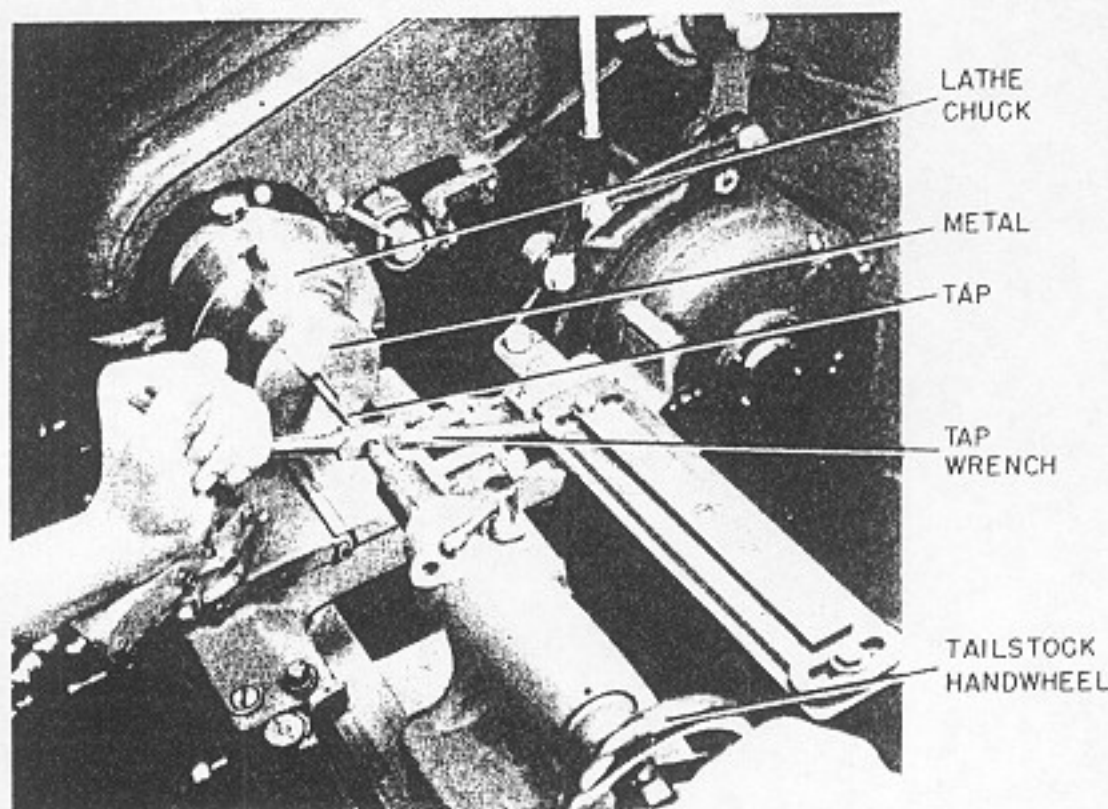


Fig. 13-39. Since the tap is supported by the dead center, threads square with the surface of the metal are cut.

fact alignment. Place a drill chuck in the tailstock spindle and clamp a drill and countersink in the chuck. Now move the drill and countersink to within 1" of the end of the metal and tighten the tailstock to the lathe bed. With the lathe running, turn the tailstock hand wheel until the point of the drill and countersink makes a

cone-shaped indentation in the end of the metal. This indentation makes it possible to start the drill on center. Stop the lathe and remove the combination countersink and drill from the drill chuck. If a straight shank drill is to be used, place a drill of the proper size in the drill chuck. If a tapered

shank drill is to be used, remove the drill chuck and insert the taper shank of the drill into the tailstock. Start the lathe. Now feed the drill into the work (see Fig. 13-38). Use oil when drilling steel. Do *not* use oil when drilling cast iron.

Using a Hand Tap to Cut Threads on the Inside of a Hole at the Lathe. To cut threads on the inside of a hole, select a tap drill of the proper size (see Table 4) and drill the hole to the required depth. Then lock the headstock spindle so that it will not turn and insert a well-oiled tap in the drilled hole. Now adjust the dead center so that its point is in the center hole of the tap. Slowly turn the tap with a tap wrench, while applying pressure to the tap by turning the tailstock hand wheel (see Fig. 13-39). Apply oil as the threads are being cut and back up the tap after each half turn. Continue to turn the tailstock hand wheel, keeping the point of the center in the center hole of the tap while you are cutting the threads.

Shaper

The shaper is used primarily for the shaping of metal surfaces. The work is held in a vise or clamped to the table. The cutting tool moves back and forth across the metal, cutting only on the forward stroke. As the tool moves backward, or just before it starts its forward movement, the table on which the vise is fastened moves sideways across the front of the shaper. This moves the metal into position for the next cut. In Fig. 13-40 is illustrated a 7-inch bench shaper. In studying this illustration, you will see that a shaper is made up of four main parts: (1) the column and base, (2) the table, (3) the ram, and (4) the tool head. All shapers, regardless of size, are similar in construction.

The Column. The column is the backbone of all shapers. It is hollow and contains the mechanism for running this machine.

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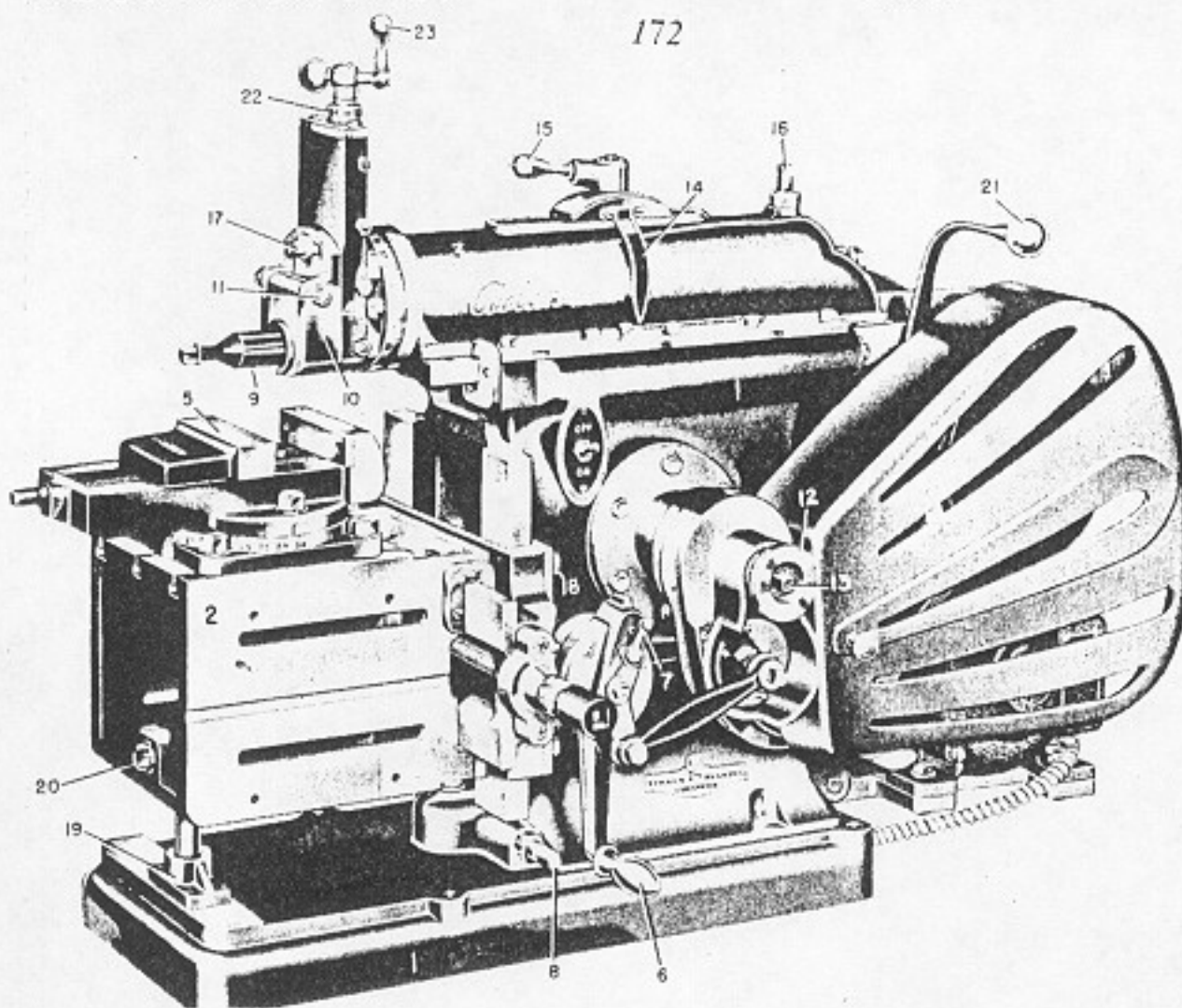


Fig. 13-40. 7-inch Bench Shaper. (Courtesy Atlas Press Co.)

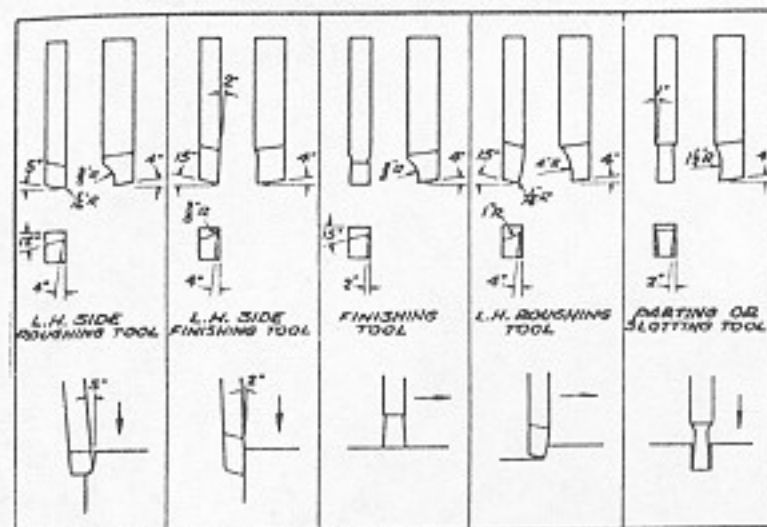
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|---------------------|----------------------------|----------------------------------|
| 1. Column and base. | 9. Tool post. | 17. Clapper box bolt. |
| 2. Table. | 10. Clapper box. | 18. Gib bolt. |
| 3. Ram. | 11. Clapper pin. | 19. Outboard table support. |
| 4. Tool head. | 12. Lock wheel. | 20. Outboard table support bolt. |
| 5. Vise. | 13. Adjusting shaft. | 21. Engagement lever. |
| 6. Table crank. | 14. Pointer. | 22. Tool slide dial. |
| 7. Feed pawl. | 15. Binder clamp. | 23. Tool slide ball crank. |
| 8. Lift shaft. | 16. Ram positioning shaft. | |

The Table. The table 2 is attached to the front of the shaper. It is finished on both sides and the top. This makes it possible to fasten the work directly to the table top or on either side. However, for most shaper operations, the work is held in the vise 5, which is bolted to the table. The table can be moved across the front of the shaper by turning the table crank 6 or by engaging the automatic feed pawl 7; it may also be raised or lowered by turning the lifting shaft 8. The crank is used to put the work into position under the cutting tool before the pawl is engaged, so that the work is fed automatically while being machined.

The Ram and the Tool Head. The ram 3 moves back and forth while the machine is in operation. In this way the tool, which is held in the tool post 9 (which is part of the tool head 4), is pushed forward across the metal on the cutting stroke and pulled backward across the metal on the return stroke. The tool does not cut on the return stroke. The clapper box 10 is hinged at the top by the clapper pin 11 to provide a means of lifting the tool during the return stroke. If this were not possible, the tool would dig a groove in the metal and its cutting edge would be dulled as the tool was being pulled backward across the

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SHAPER CUTTING TOOLS RECOMMENDED FOR MILD STEEL



SHAPER CUTTING TOOLS RECOMMENDED FOR CAST IRON

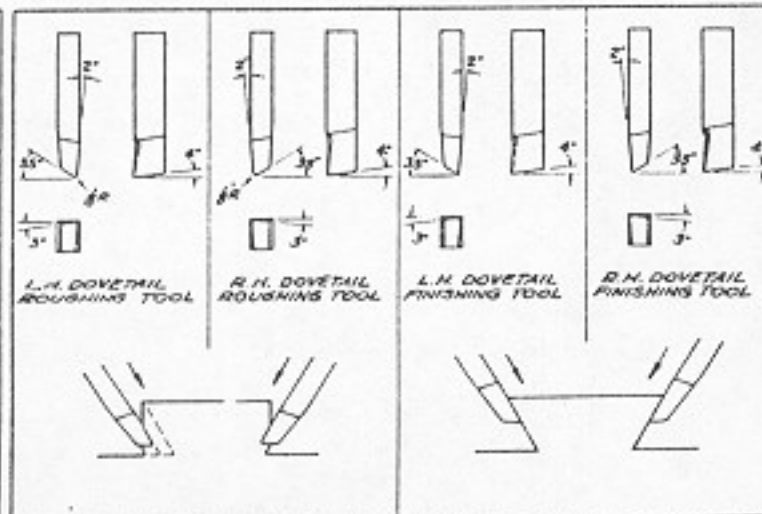


Fig. 13-41. Always use a sharp tool that has been ground properly for the work being machined. The use of an oil stone on the cutting edge after grinding gives a sharper edge. (Courtesy Cincinnati Shaper Co.)

metal.

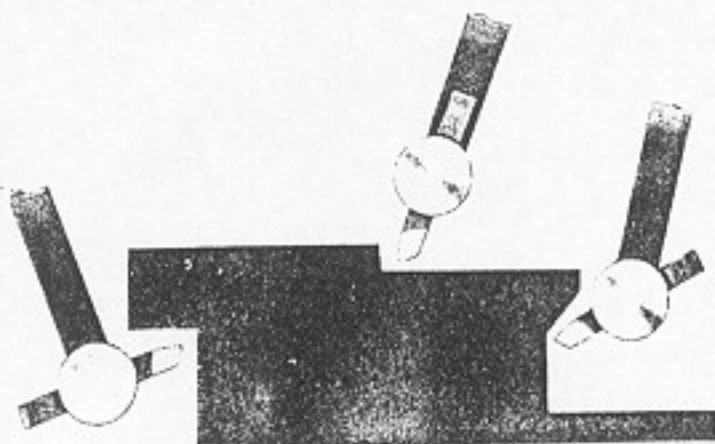
Adjusting the Stroke Length. The sizes of all shapers are designated by the length of the strokes, which are measured in inches between the extreme forward movement and the extreme backward movement of the ram, such as a 7-inch, a 16-inch, or a 36-inch shaper.

Seldom is the work being shaped of the same length as the stroke of the shaper. Therefore, a means is provided for adjusting the length of the stroke to fit the work being shaped. This is done by loosening the knurled lock wheel 12 and then turning the stroke adjusting shaft 13 until the pointer 14 indicates the length of the stroke. The stroke length should always be set when the ram is at the extreme backward point of its return stroke. After setting the stroke length, always tighten the lock wheel.

Positioning the Stroke. After the stroke length has been set, the ram must be adjusted so that the movement of the tool will be directly over the work. This is known as positioning the stroke. To do this, the binder clamp 15 is loosened and the ram positioning shaft 16 is turned until the tool is adjusted to within $\frac{3}{4}$ to $1\frac{1}{4}$ inches from the back edge of the work. Once the stroke has been positioned, always be sure to tighten the binder clamp.



(a)

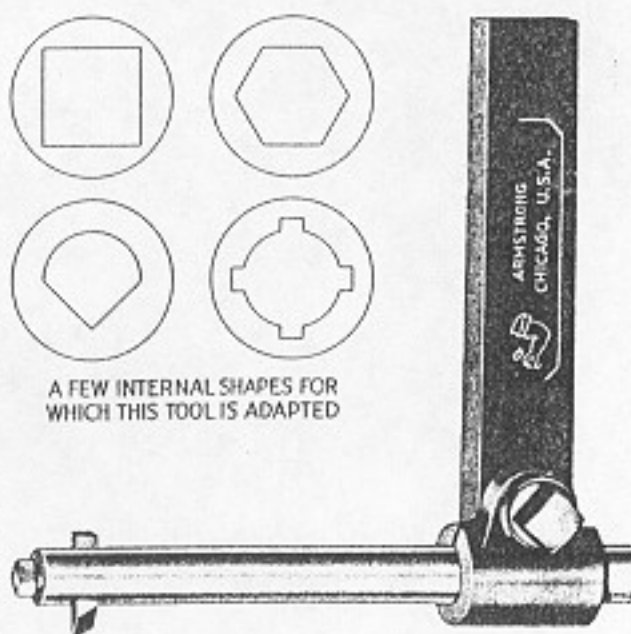


(b)

Cutting Tools. Cutting tools for the shaper are similar to those used on the lathe in that they are single-point cutting tools and are ground with relief and clearance on them. To understand better the shape of the different tools used for mild steel and cast iron, study Fig. 13-41 carefully. In use, the cutting tool is held in a tool holder

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(see Fig. 13-42). A one-piece tool bit, large enough to be held in the tool post without first being clamped in a tool holder, may be used. When it is necessary to shape the inside of a hole, an extension-type tool holder (see Fig. 13-43) is used.

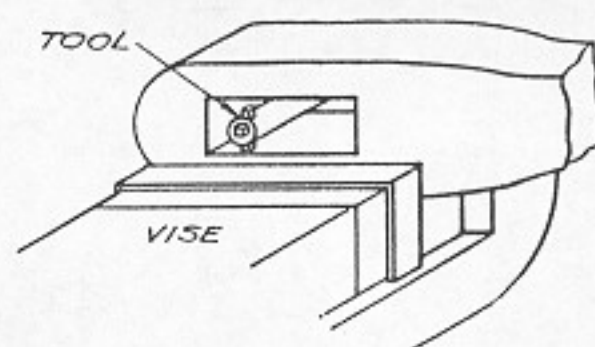


A FEW INTERNAL SHAPES FOR WHICH THIS TOOL IS ADAPTED

(a) Extension tool holder for the shaper. (Courtesy Armstrong Bros. Tool Co.)

Shaper Operation. When shaping, it is important to hold the work se-

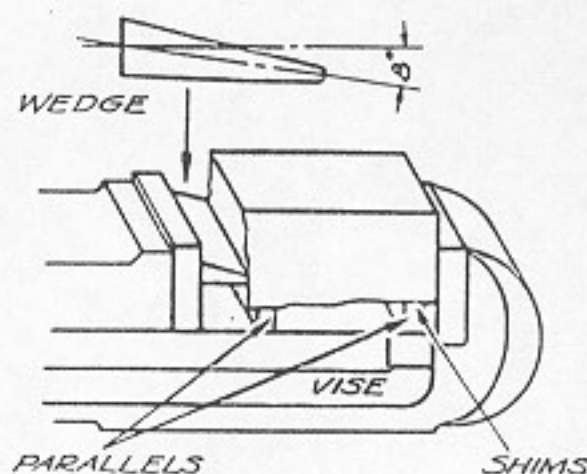
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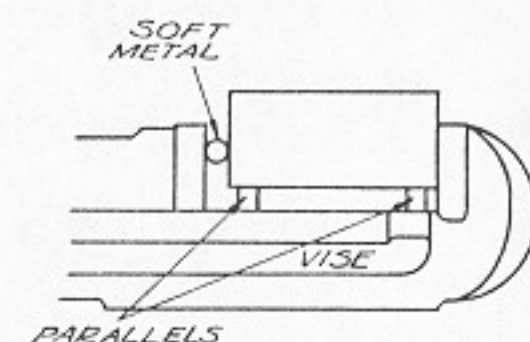
INTERNAL SHAPING

(b) Extension tool holder in use. (Courtesy Cincinnati Shaper Co.)

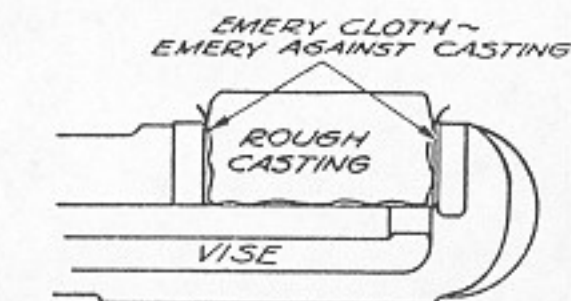
Fig. 13-43. Internal flat and irregular surfaces as well as keyways are shaped with the extension tool holder.



(a) Holding metal to shape one side at right angles to an edge.



(b) Holding metal to shape one side parallel to the opposite side.

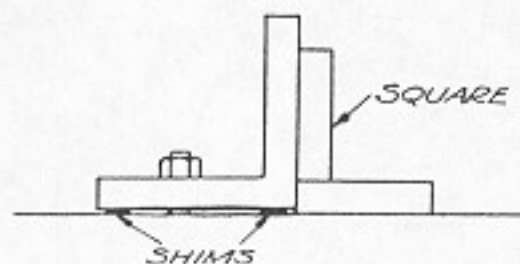


(c) Holding rough castings for shaping.

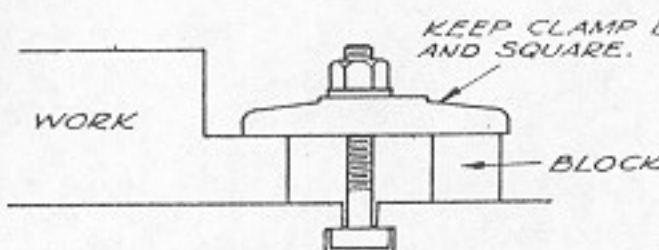
Fig. 13-44. The work to be done and the shape of the metal govern how it will be held in the shaper vise. (Courtesy Cincinnati Shaper Co.)

curely and solidly, so that it will not give or spring out of shape while it is being machined. The majority of work is held in the vise, which is bolted to the shaper table. There are several approved methods of clamping the metal in the vise. A study of Fig. 13-44 will acquaint you with three of them. Before placing your work in the vise, be sure to clean the vise and the metal thoroughly. If necessary, use a file to remove the burrs from the metal. Place the metal in the vise with the true side against the solid vise jaw. If the opposite side is not true, use a holddown or a round piece of soft steel (see Fig. 13-44a and b) and tap the work with a soft-face hammer to seat it firmly. If necessary, place shims under the metal so that it will be properly seated on the base of the vise. Rough castings are generally held as

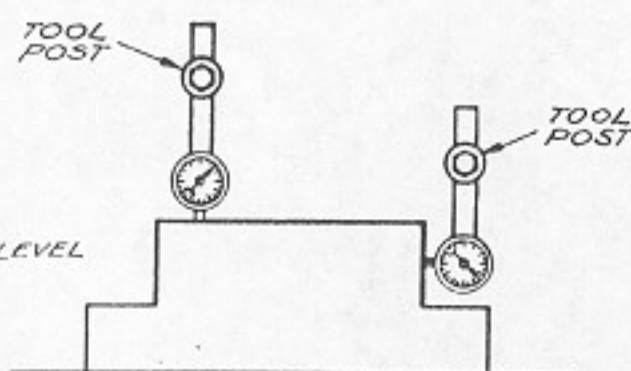
held in the vise or clamped to the table, a check should be made to see if it is level, straight, or square. This can be done as shown in Fig. 13-46 by using a precision square, an indicator, or a surface gage. If it is necessary to level the work, loosen it and place shims under it. After tightening, again



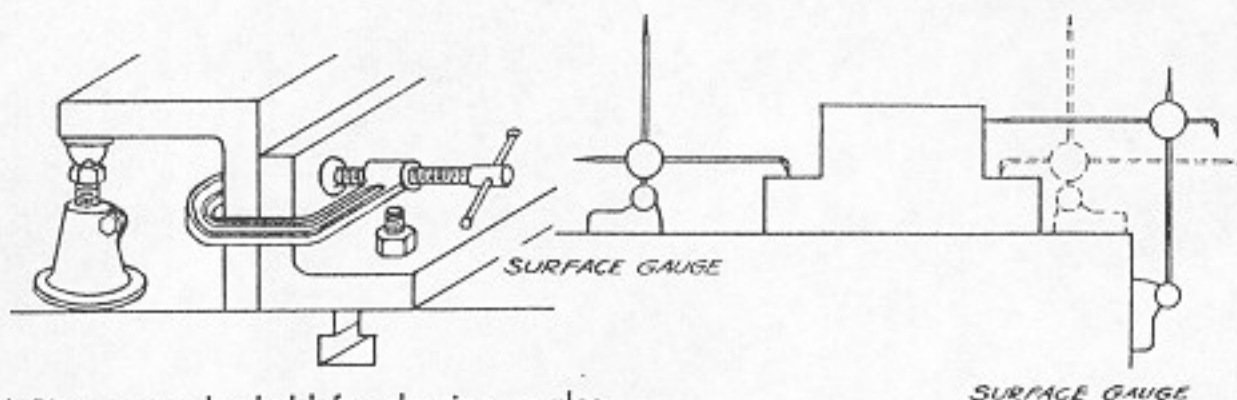
(a) Squaring up an angle with precision square.



(a) Clamping work to the table with a T bolt, a strap, and a block.



(b) Using indicators for a high degree of accuracy in leveling the work.



(b) Pieces may be held for shaping angles by clamping them to angle plates.

Fig. 13-45. The work can be held just as rigidly when clamped to the shaper table as when it is held in a vise. (Courtesy Cincinnati Shaper Co.)

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illustrated in Fig. 13-44c. If the work is too large or of such a shape that it cannot be held in the vise, it may be clamped to the shaper table as shown in Fig. 13-45.

After the work has been securely

check the work.

You are now ready to fasten the cutting tool in the tool post and to set the clapper box properly. The tool is

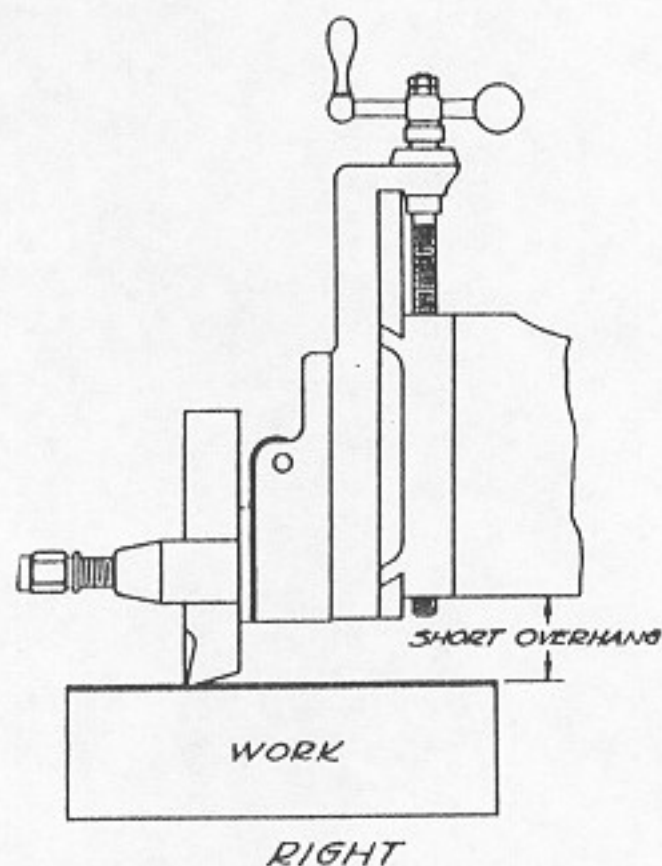
set in a vertical position, with a small amount projecting down from the bottom of the clapper box as shown in Fig. 13-47a. After setting the tool, adjust the clapper box by loosening the clapper box bolt 17 (see Fig. 13-40), and move the top of the box until it slants slightly away from the cutting edge of the tool. After setting the clapper box, be sure to check the tool to see that it is still in a vertical position. A careful study of Fig. 13-48 will illustrate to you the right and wrong ways of setting the tool and the clapper box. After setting the cutting tool, set the length of the stroke and then position the stroke to the work as previously explained.

Now that the work is properly held in the machine and the tool properly set, you are ready to start shaping the work. Carefully move the ram forward until the cutting tool is over the sur-

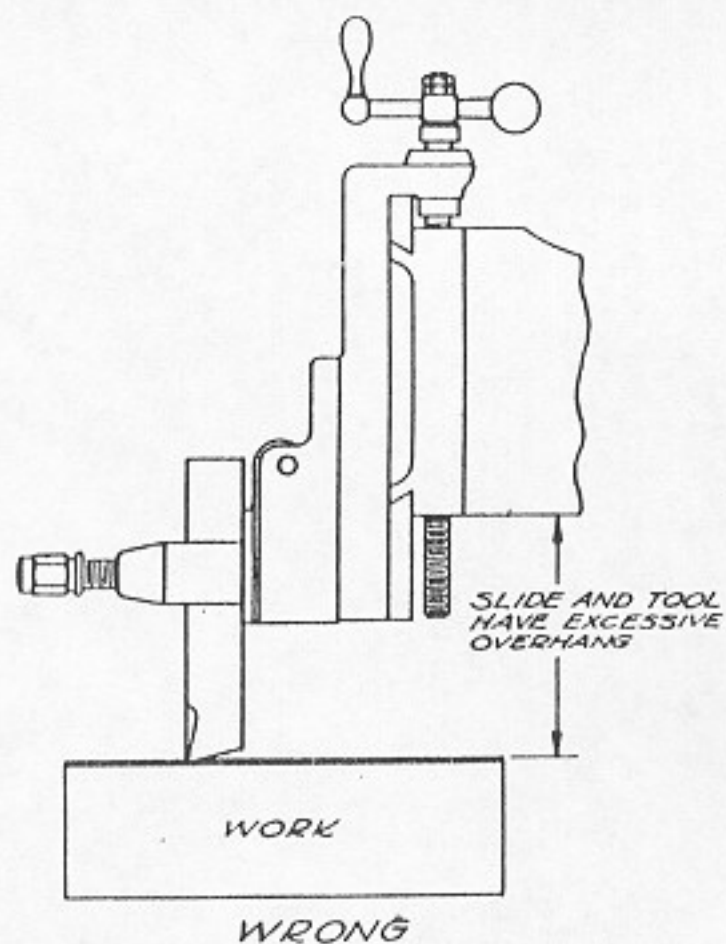
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face to be machined. Loosen the gib bolts 18 (see Fig. 13-40). By turning the lift shaft 8, raise the shaper table until the top surface of the metal is about one inch below the bottom of the ram. Tighten the gib bolts. Lower the outboard table support 19, and lock it by tightening the outboard support bolt 20. You are now ready to turn on the switch and start the ram by moving the engagement lever 21. As the ram is moving back and forth, carefully turn the tool slide ball crank, lowering the tool until it just touches the surface to be machined. Move the table to the left by turning the table crank until the work has been moved out from under the cutting tool. Set the tool slide dial 22 at 0. When this has been done and as you turn the crank 23, you can read in thousandths of an inch how much you are lowering the cutting tool. The depth of the first cut is governed by the amount of metal to be removed and by the power of the shaper. The initial cut is a roughing cut, as shown in Fig. 13-49. This cut is taken to bring the work to within a few thousandths of an inch of its fin-

Fig. 13-46. Leveling and setting work square for shaping. (Courtesy Cincinnati Shaper Co.)

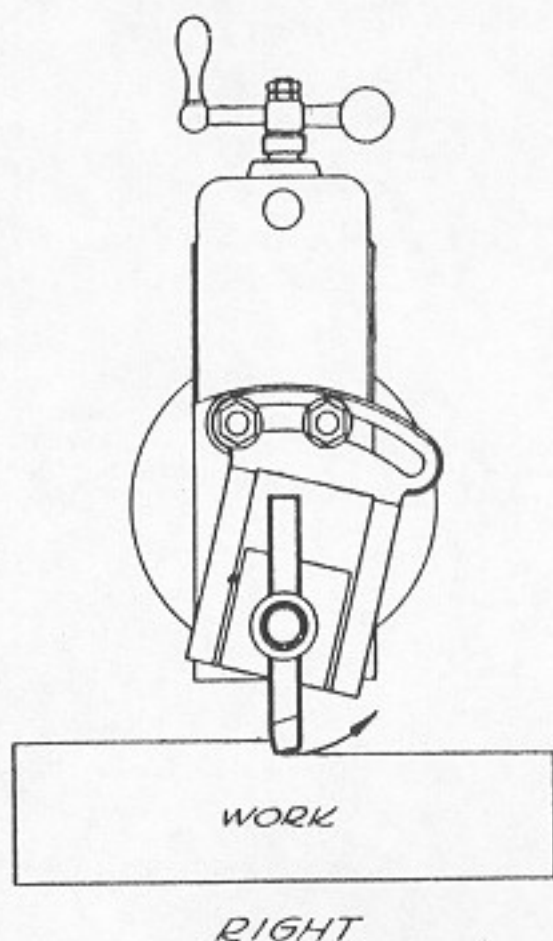


(a) Keep the bottom of the tool slide even with the bottom of the ram whenever possible.

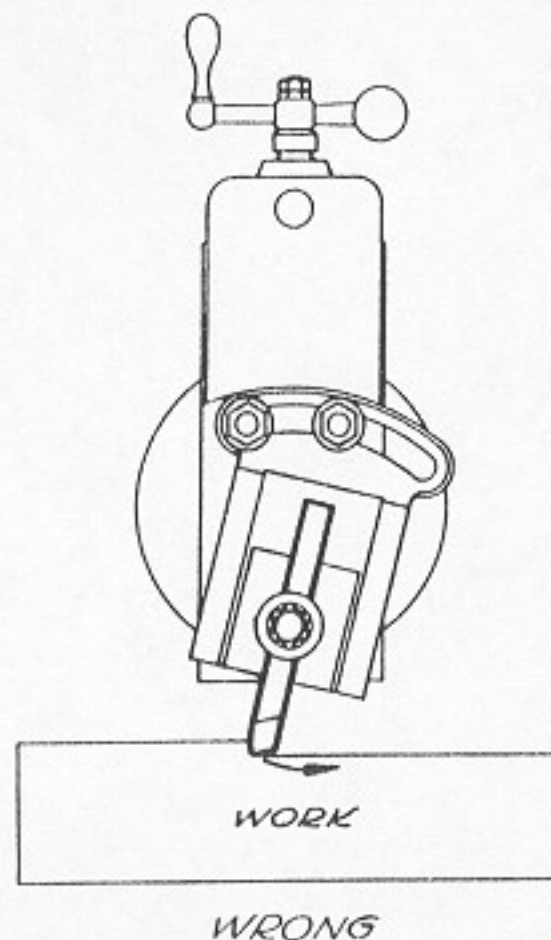


(b) Shows too great an overhand of the tool and tool slide. This may cause the tool to chatter or the tool slide to break.

Fig. 13-47. Adjusting the tool slide for shaping. (Courtesy Cincinnati Shaper Co.)



(a) The tool should be set straight up and down.



(b) When the tool is set on an angle it has a tendency to dig into the work.

Fig. 13-48. Setting the tool for shaping. (Courtesy Cincinnati Shaper Co.)

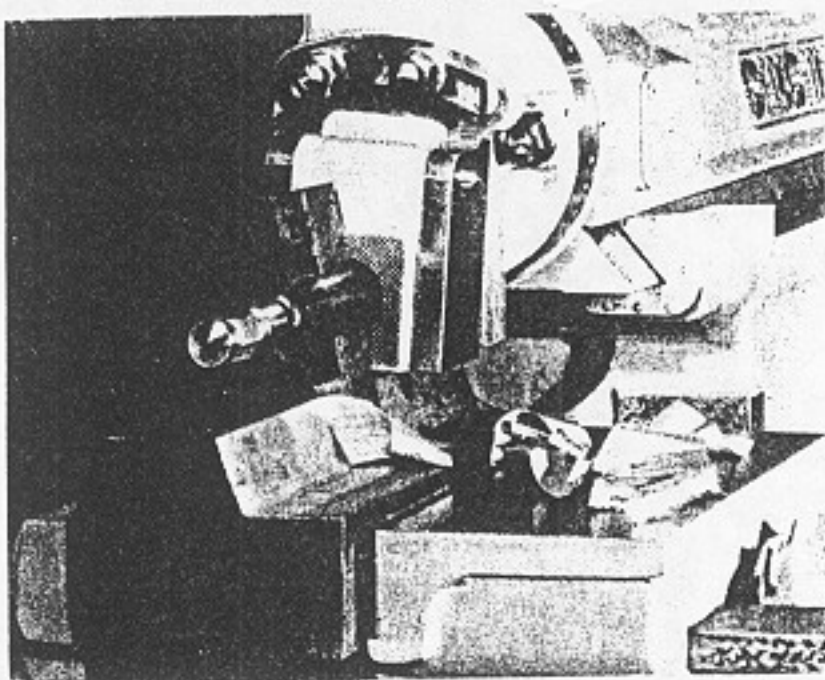
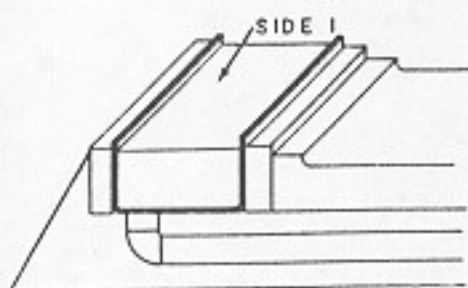
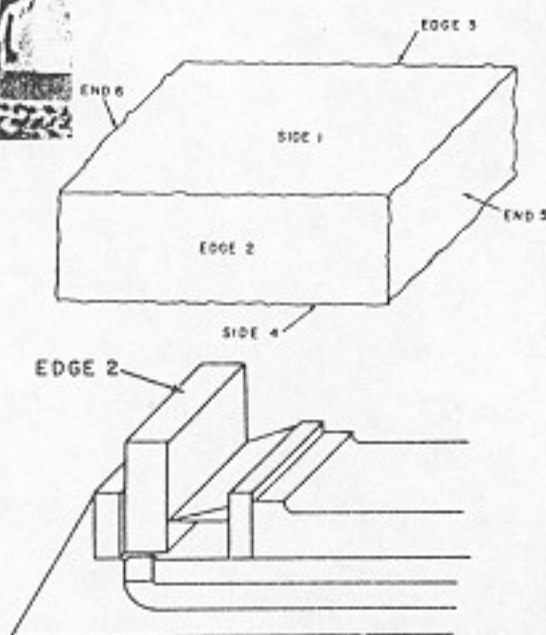


Fig. 13-49. The maximum depth of a roughing cut is generally from 110 to 125 thousandths of an inch. (Courtesy Cincinnati Shaper Co.)

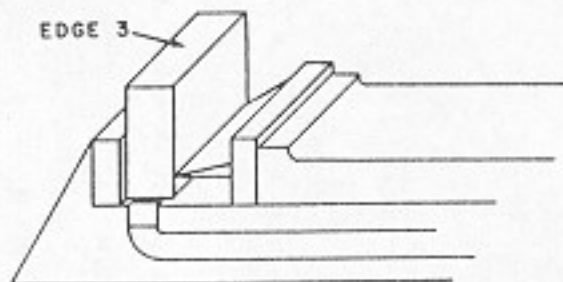
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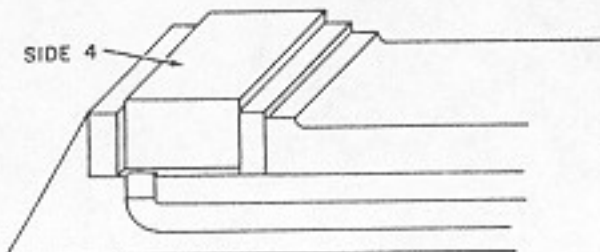
(a) Side 1 of metal is set as level as possible and then shaped.



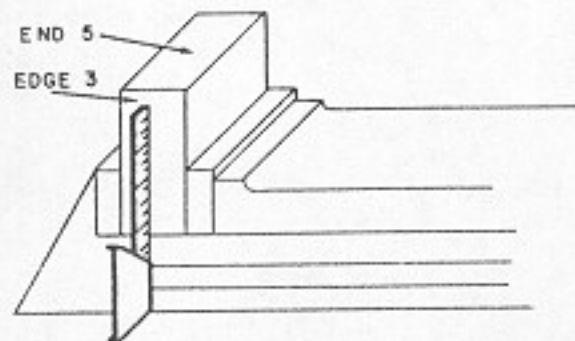
(b) Side 1 is then placed against the stationary jaw of the vise and edge 2 leveled before shaping.



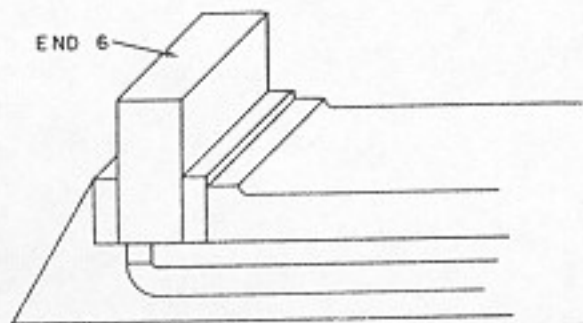
(c) Side 1 is placed against the stationary vise jaw, and edge 2 flat on the base of the vise before edge 3 is shaped.



(d) Side 1 is placed flat on the base of the vise before side 4 is shaped.



(e) End 6 is placed on base of vise, then edge 3 is adjusted until parallel with the blade of a square that is held against the square side of the shaper table, after which end 5 is shaped.



(f) End 5 is placed flat on base of vise before end 6 is shaped. In this step it is a good plan to check with the edge of a rule, as in (e), before shaping.

Fig. 13-50. Squaring a block of metal at the shaper.

ished dimensions; sometimes more than one roughing cut is necessary. The general practice is to leave from ten to fifteen thousandths of an inch for a finishing cut on steel. For cast iron, from five to ten thousandths of an inch is left for finishing.

Engage the automatic table feed and take the first roughing cut across the entire width of the surface being machined. When this cut has been finished, disengage the automatic table feed and stop the movement of the ram. Slowly move the ram to its furthest back position. Now move the work back to its starting position and carefully lower the tool for a finishing cut. Again, turn on the switch, start the ram, and engage the table to make the finishing cut across the surface being worked.

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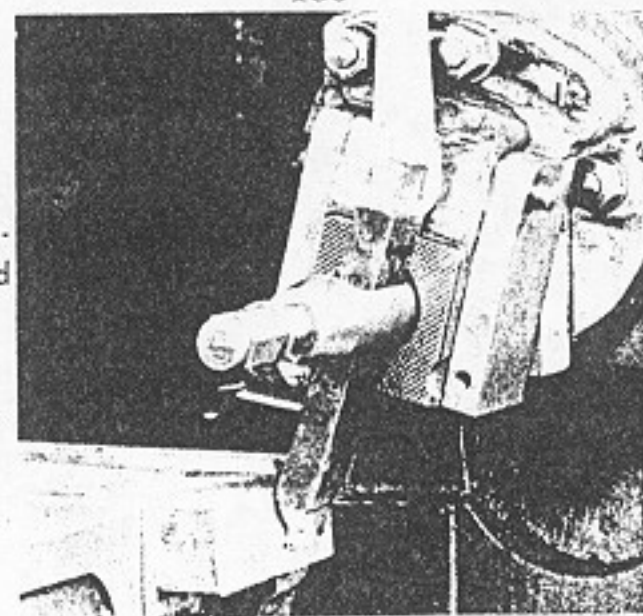


Fig. 13-51. Vertical surfaces are shaped by feeding the tool slide manually. (Courtesy Cincinnati Shaper Co.)

In metal working, the shaper is used for several different machining operations, the most common of which are squaring a piece of metal (see Fig. 13-50), shaping a vertical surface (see Fig. 13-51), angular shaping (see Fig. 13-52), cutting internal and external keyways (see Fig. 13-53), and contour shaping (see Fig. 13-54).

Safety Precautions. The backward and forward movements of the ram present a serious accident hazard. It is quite possible that the operator's

Fig. 13-52. Angular shaping is done by setting the tool slide at an angle and feeding the tool slide manually. (Courtesy Cincinnati Shaper Co.)

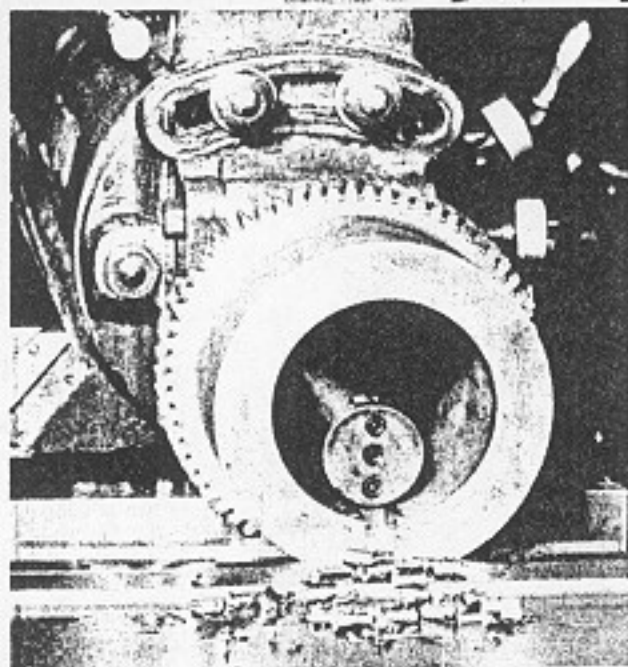
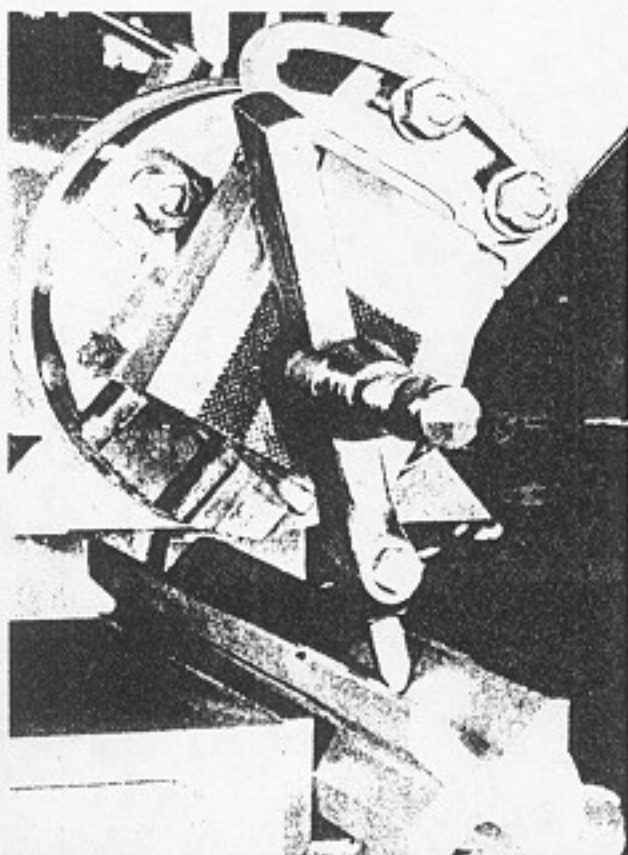
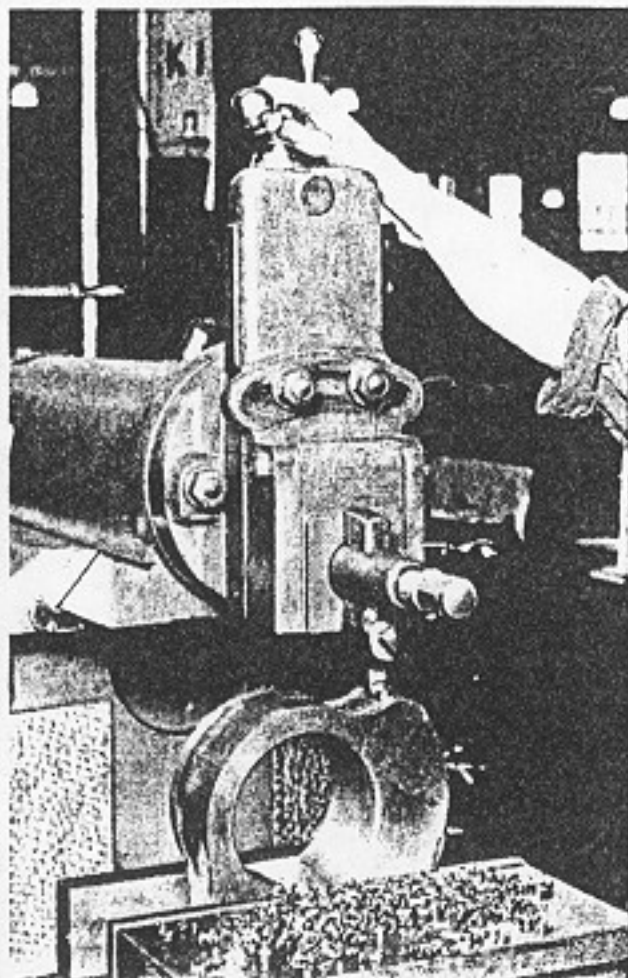


Fig. 13-53. Internal keyways are cut with the extension tool holder while the tool slide is being fed manually. Keyways can be cut at the end of shafts or in any location along a shaft.

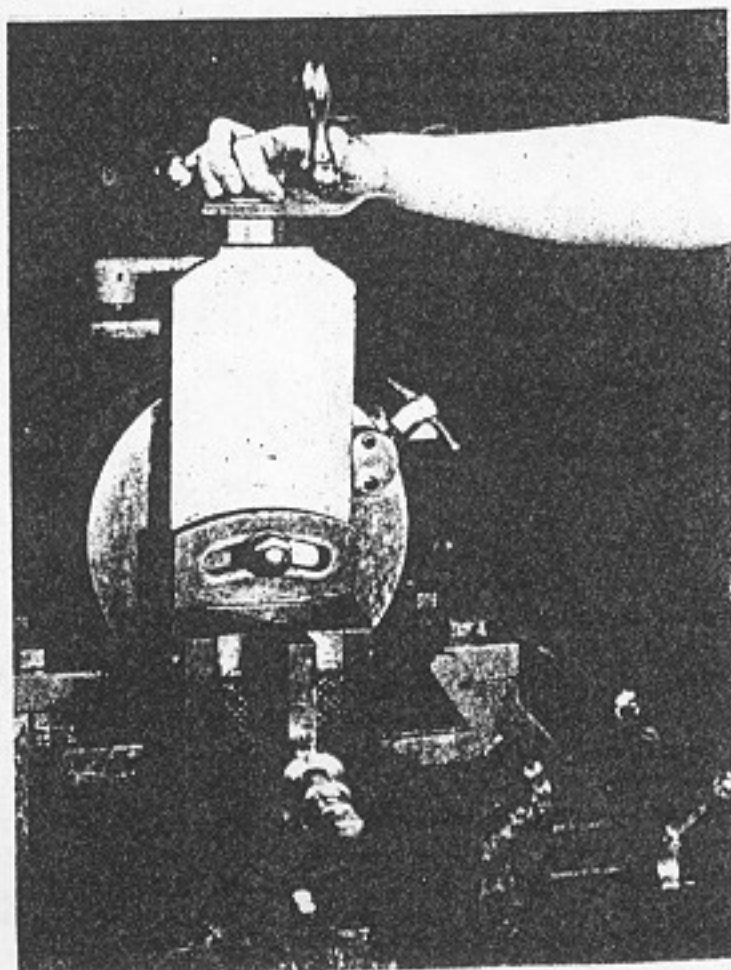
fingers or hand may become caught between the tool and the work or between the tool head and the column. Whenever the ram is in motion, the operator should stand, not in front of the ram, but off to a side, and when it is necessary for him to feed the tool slide by hand, his arm should extend straight out from his shoulder, as shown in Fig. 13-55. When operating the

Fig. 13-54. Contour shaping is done by first laying out the contour and then raising or lowering the cutting tool by turning the tool slide ball crank so that the tool will cut to the layout line.



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Fig. 13-55. For safe manual operation of the tool slide while the ram is in motion, the operator must keep his arm up and above all parts of the shaper.



shaper, he should wear safety goggles so that chips will not enter his eyes, and his hands should be kept away from the danger points. When it is necessary to remove chips from the work, he should always use a brush.

Milling Machine

In the metal working industry, the milling machine ranks second to the lathe in importance. Industry requires the use of many different sizes of machines, ranging from huge machines larger than a piano to the small bench type, which are about the size of a bass drum. Most milling machines are made so that the cutter is held in a horizontal position; this machine is known as a horizontal mill. By the same token, one that is made to hold the cutter in a vertical position is known as a vertical milling machine.

The vertical milling machine is made for the cutting of irregular shapes, edges, and curves without the use of special form cutters. On the other hand, the horizontal milling machine cuts in both the flat or horizontal position and the upright or vertical position. For this reason, you will find more horizontal than vertical milling machines in use.

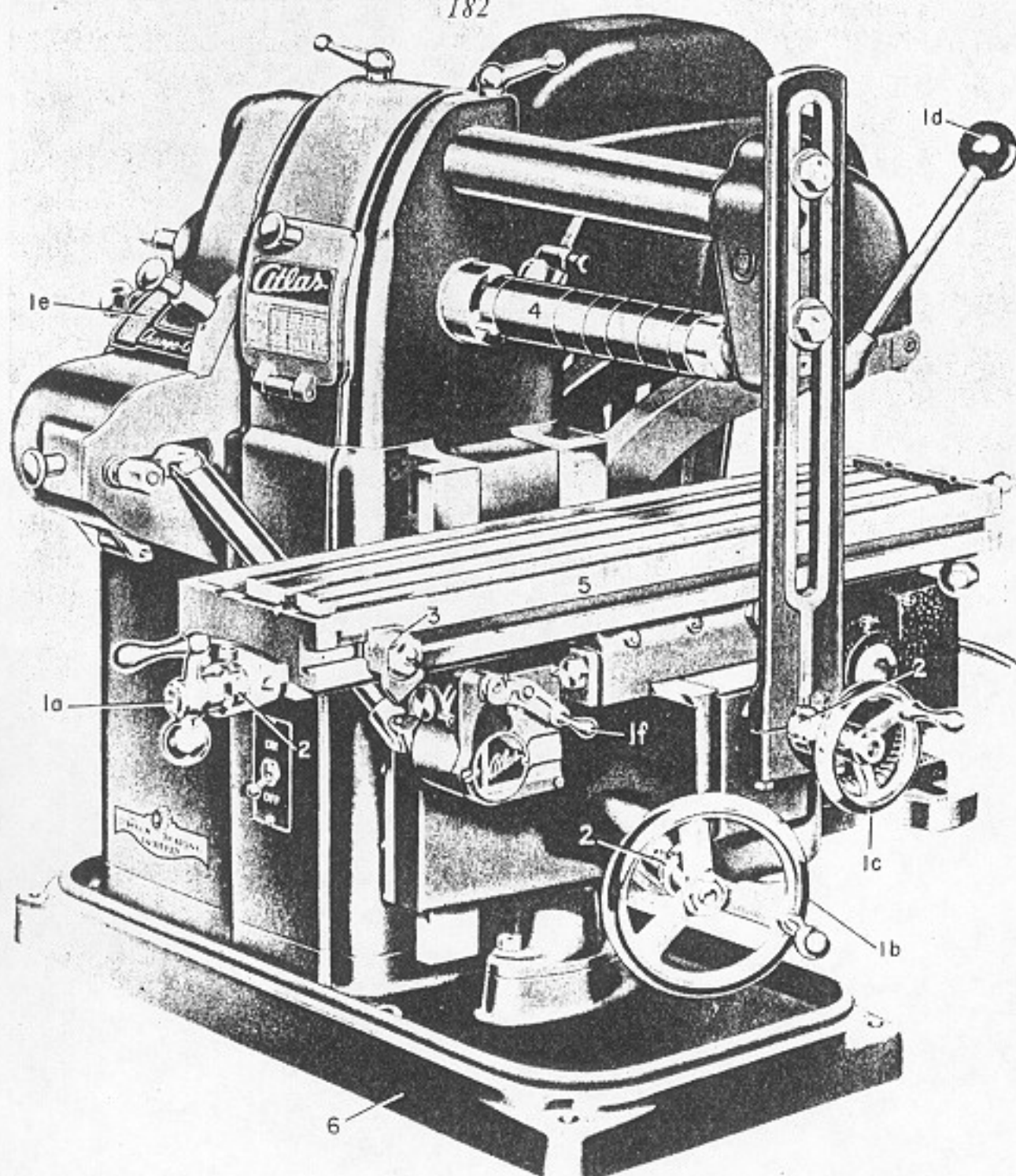


Fig. 13-56. Bench Milling Machine. (Courtesy Atlas Press Co.)

- 1a. Table screw ball crank.
- 1b. Elevating screw hand wheel.
- 1c. Cross feed hand wheel.
- 1d. Belt tension lever.
- 1e. Quick-set automatic table feed mechanism.

- 1f. Go-stop table lever.
- 2. Micrometer dials.
- 3. Feed trip dog.
- 4. Arbor.
- 5. Milling machine table.
- 6. Base.

Before attempting to operate a milling machine or even to turn a handle on one, the student should thoroughly

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acquaint himself with all the various parts of the machine by carefully studying Fig. 13-56; he should pay particular attention to the cranks and levers 1a through 1f, which control the movements of the machine, as well as the micrometer dials 2 on the table

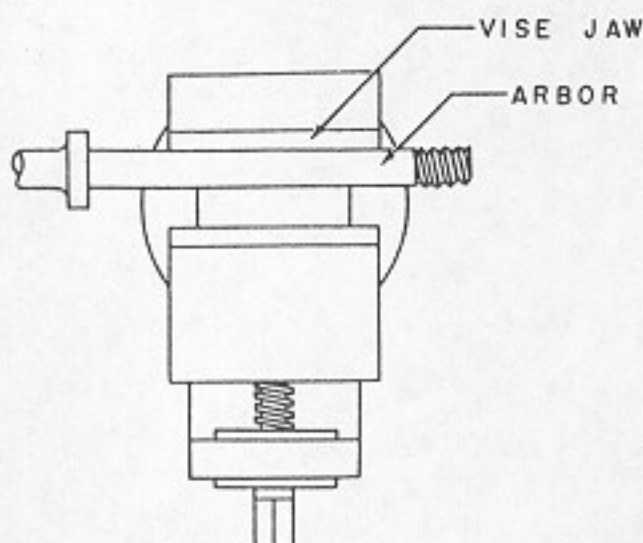
feed, the cross feed, and the vertical adjustment screw. These dials make possible the adjustment of the work in relation to the cutter to within .001 of an inch. Again, as with all machining operations, the ease and accuracy with which the metal is cut in a milling machine depends upon the cutting tools and how they are used.

Milling Machine Operations. The milling machine is used to cut flat

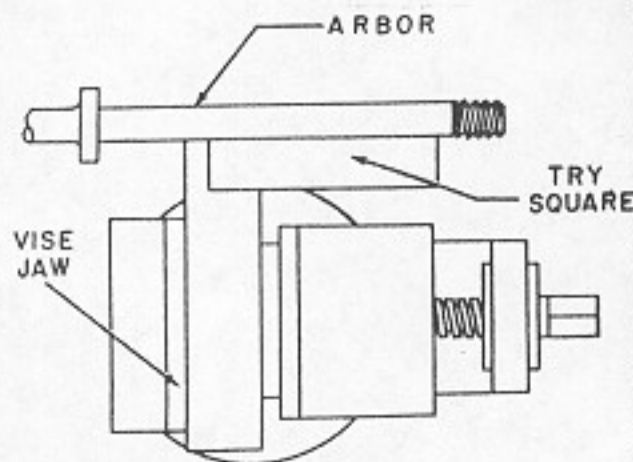
surfaces or irregular shapes on pieces of metal. To do this, fasten or hold the work securely to the milling machine table. This is done by bolting a milling machine vise to the table of the milling machine (see Fig. 13-57) and either gripping the work in the vise or clamping the work directly to the milling machine table (see Fig. 13-58). After the work has been securely fastened to the table, it is fed against a revolving cutter, which mills the metal until it has been worked to the desired dimensions. These cutters are held on the arbor or in the spindle socket of the milling machine. The cutters themselves are made in a wide range of shapes and sizes from either carbon or tool steel. Cutters made of tool steel are preferred, for they can be operated at a higher speed and will generally outlast those made of carbon steel. The power for turning the cutters is usually supplied from an electric motor through belts or gears connected to the spindle. By changing the belts or gears, it is possible to obtain different cutter speeds. The table on which the work is clamped can be moved lengthwise under the cutter. This is known as the longitudinal feed. Also, it can be moved crossways under the cutter. This is known as the cross feed. The table may also be raised or lowered in what is known as the vertical feed. On some machines, all of these feeds may be automatic; on others, one or two may work automatically and the others may be worked manually. The movement of the metal against the cutter is known as feed, and the rate at which the cutter revolves as it cuts is known as speed. The relationship between speed and feed in milling work is very important. It is so important, in fact, that in industry a mathematical formula is used to determine the correct speed and feed for each kind of work being done. However, for our use, the general recommendations of cutter speeds as shown in Table 6 will serve.

TABLE 6
SPEED FOR MILLING CUTTERS

Kind of Material	Cutter Speed in Feet Per Minute for High Speed Steel Cutters (About Half This Speed for Carbon Steel Cutters)	
	Minimum Speed	Maximum Speed
Soft Steel	60	90
Tough Steel	50	60
Tool Steel	60	80
Machinery Steel	80	100
Cast Iron	70	100
Brass, Bronze, and Aluminum	150	200



(a) To set the vise square with the table, adjust the vise until the whole length of the jaw (a) touches the arbor (b).



(b) To set the vise parallel to the table, hold the head of the square against the arbor (b) and adjust the jaw (a) of the vise until it is parallel to the blade (c).

Fig. 13-57. Setting the vise square with or parallel to the milling machine table.

The table feed to match the cutter speed on a milling machine is governed by the material being machined, the type of cutter being used, and the strength or solidness of the machine.

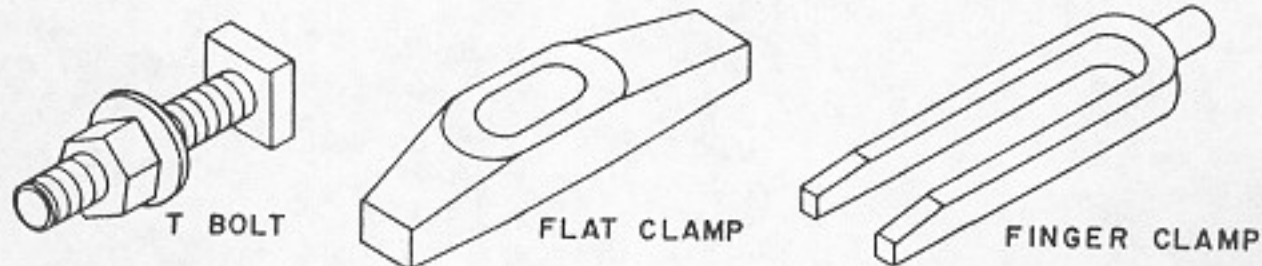
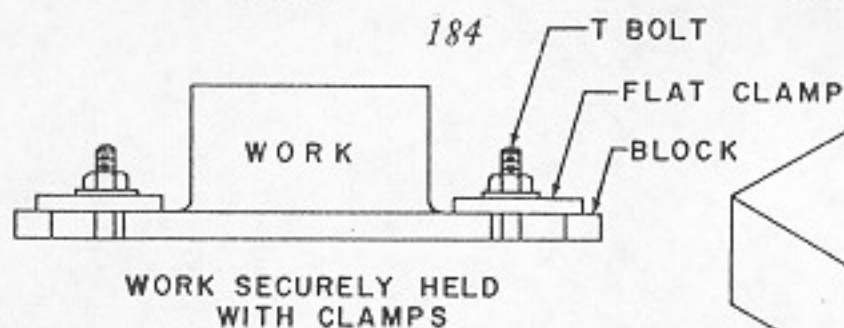


Fig. 13-58. When necessary, clamp the work to the milling machine table with T bolts, clamps, and blocks.

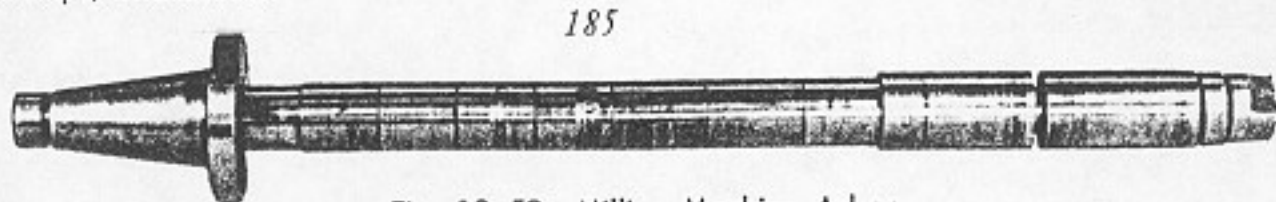


Fig. 13-59. Milling Machine Arbor.

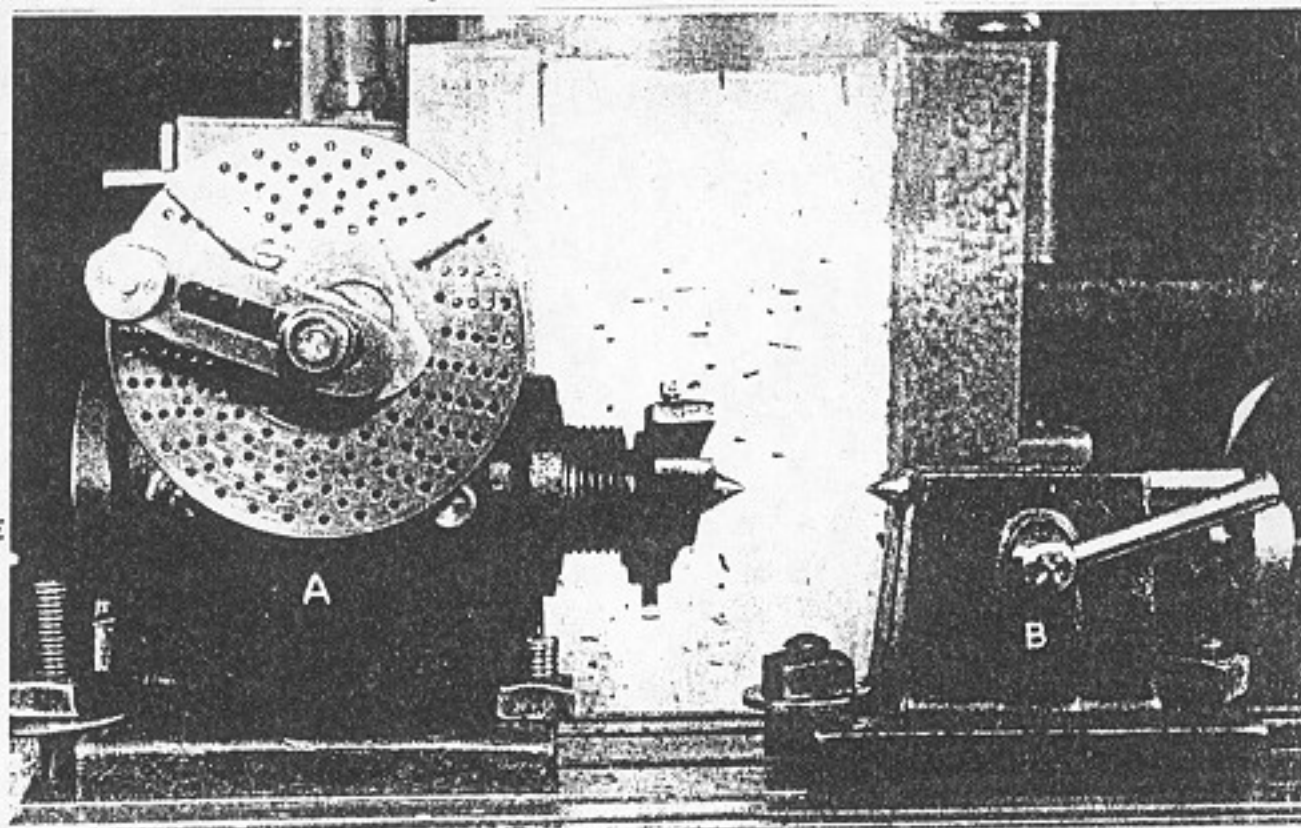


Fig. 13-60. Indexing Head and Tailstock.
(a) Indexing head. (b) Tailstock.

For instance, light machines dictate light feeds and light cuts; heavy machines permit fast feeds and heavy cuts. Milling machine cutters are held on the milling machine arbor (see Fig. 13-59) or on adapters that are held in the spindle socket of the machine. It will be noted by studying the illustration of

the arbor that it is made up of a straight piece of metal with several collars that are held on the shaft by a nut. In use, the cutter takes the place of one or more of these collars and is held securely by the use of a key and the tightening of the nut at the end of the arbor.

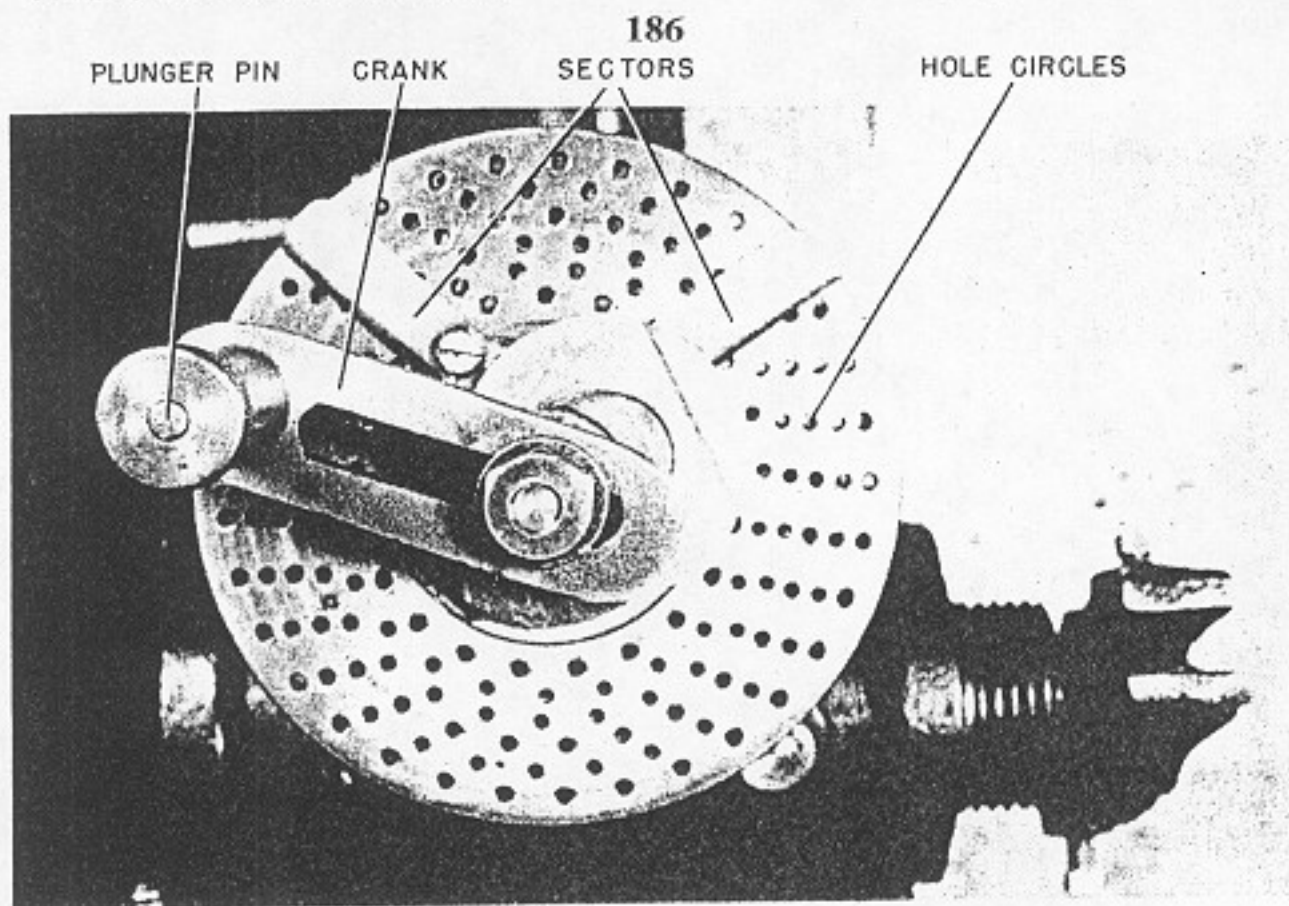


Fig. 13-61. Always be very careful when using the indexing head, as it is very easy to make a mistake by stopping the crank over the wrong hole. When this is done, your work is spoiled.

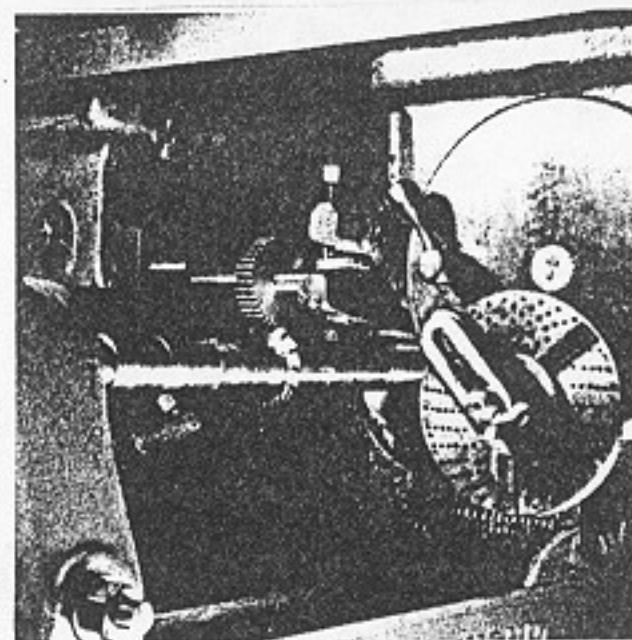


Fig. 13-62. One use of the indexing head is to divide a gear blank into spaces of equal size when cutting a gear at the milling machine.

Indexing Head. An indexing head is an attachment that makes it possible to divide a circle into equal parts. It is sometimes called a dividing head. An indexing head and center (see Fig. 13-60) can be rotated on its axis throughout a complete revolution or any part of a revolution. The work is held between the centers or in a chuck fastened to the indexing head.

To rotate the work, turn the crank on one side of the indexing head. One turn of the crank causes the work to rotate one-fourth of a complete revolution. For the purpose of indexing, a plate behind the crank contains a number of complete circles. Each of these has a different number of holes. After determining how many full or part turns are necessary to divide a complete revolution of the work into equal parts, the plunger pin on the crank is adjusted to the hole circle to be used and the two arms or sectors are set. This enables the operator to start and stop his crank correctly (see Fig. 13-61). Fig. 13-62 illustrates only one of the many uses of the indexing head.

Milling Cutters and Their Use.
Plain Milling Cutter. The milling cutters shown in Fig. 13-63 are known as plain or slab mills. These are used for the machining of a metal surface

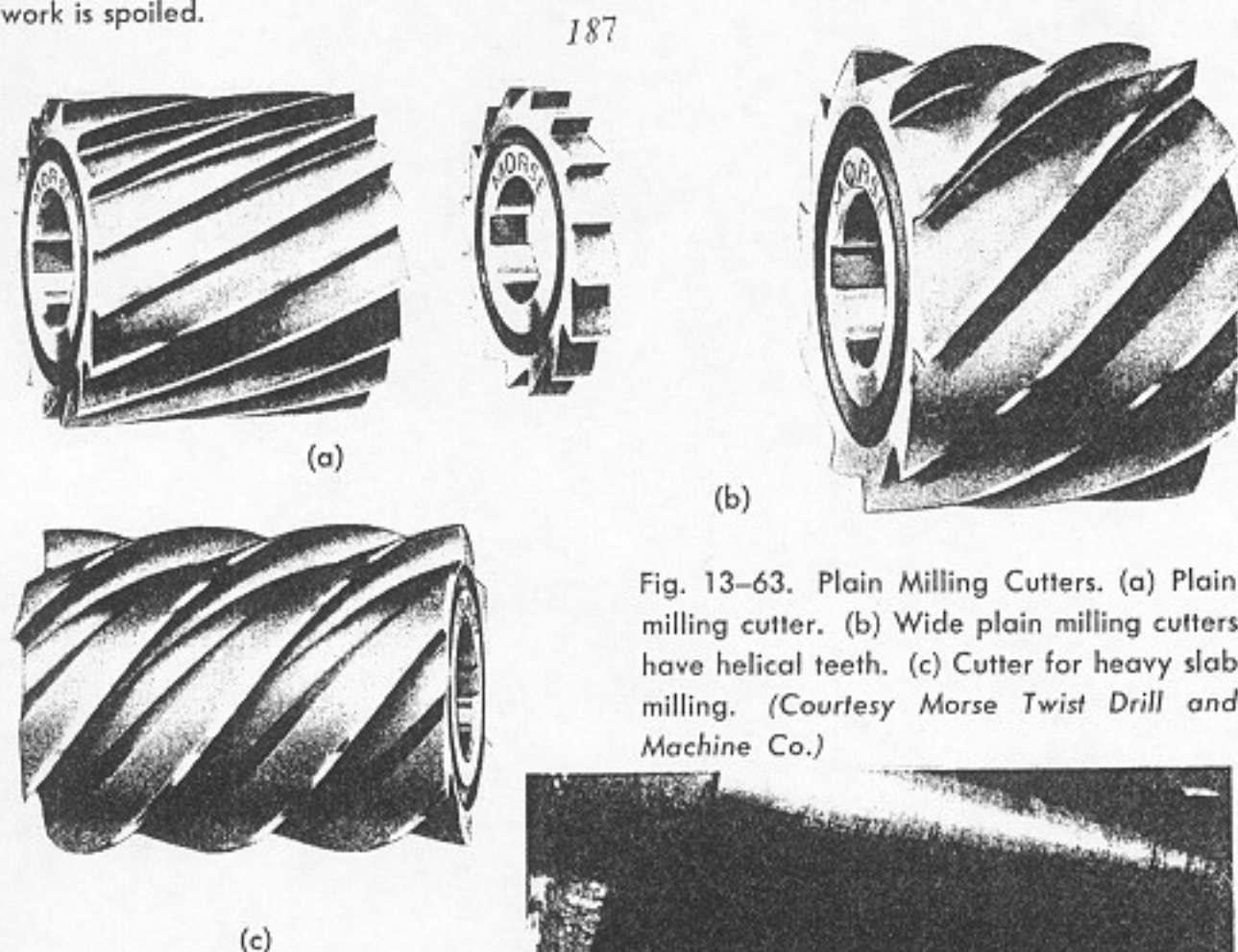
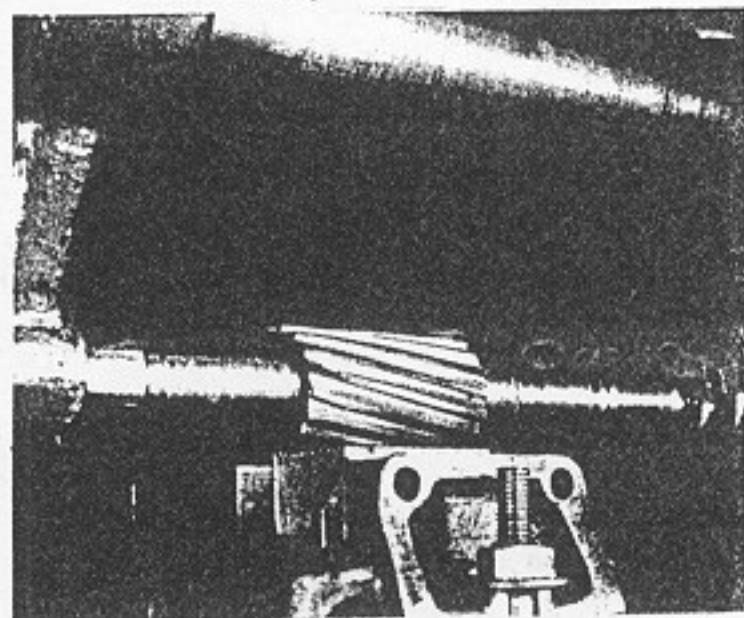


Fig. 13-63. Plain Milling Cutters. (a) Plain milling cutter. (b) Wide plain milling cutters have helical teeth. (c) Cutter for heavy slab milling. (Courtesy Morse Twist Drill and Machine Co.)

Fig. 13-64. In plain or slab milling, the cutter is held on the arbor and the work is held in the vise or clamped to the table.



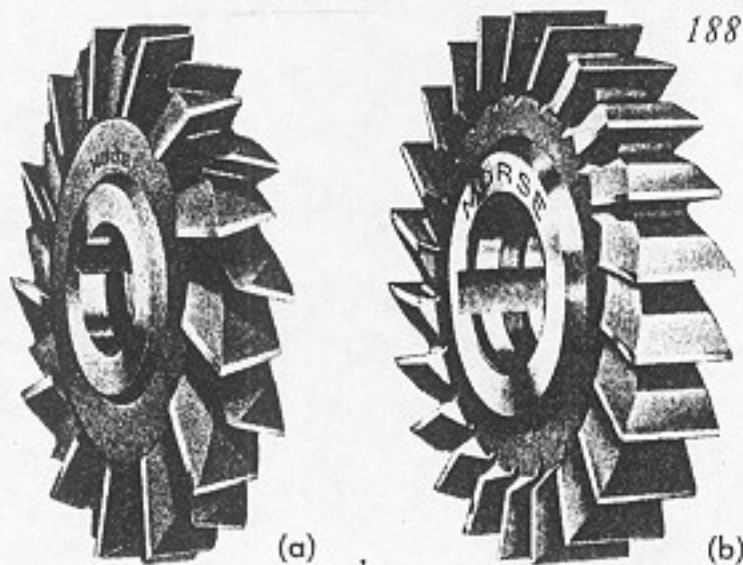
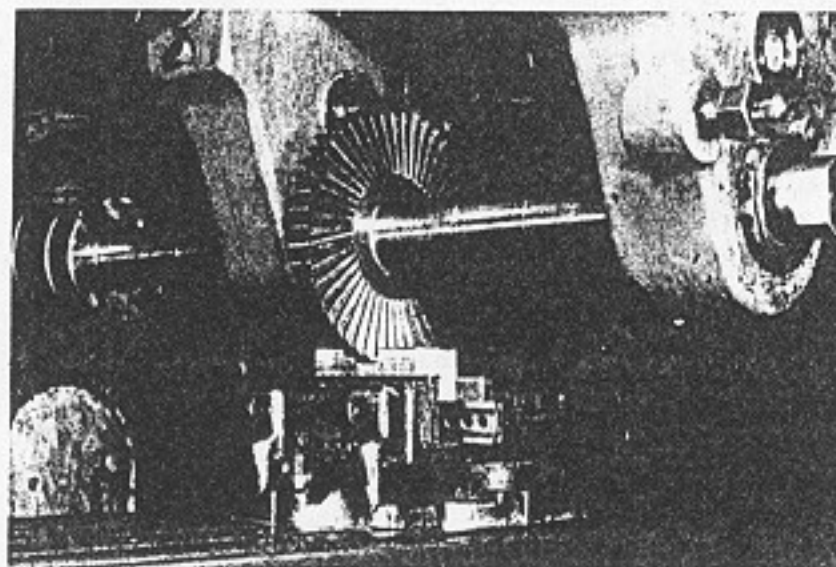


Fig. 13-65. Side Milling Cutters.
(a) Straight-tooth side milling cutter.
(b) Stagger-tooth side milling cutter.
(Courtesy Morse Twist Drill and Machine Co.)

Fig. 13-66. The side mill is held on the milling machine arbor the same as is the plain mill. The difference that will be noted is that the cut is made down and into the metal instead of on the top surface.



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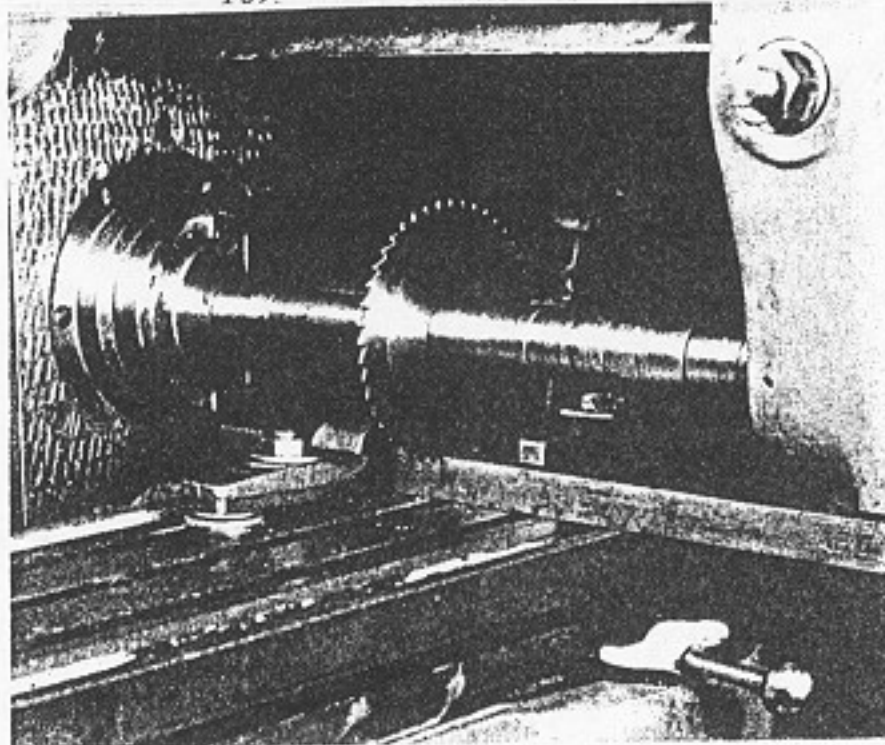


Fig. 13-68. It is generally necessary to feed the slitting saw at a slow rate of feed.

that is less than the width of the cutter or equal to its full width. This milling operation is known as plain or slab milling. Fig. 13-64 shows a plain milling cutter slab milling the edge of a piece of metal.

Side Milling Cutters. Side milling cutters are shown in Fig. 13-65. In studying this illustration, you will note

that this cutter has teeth on both sides as well as around the outside edge. Fig. 13-66 shows the side milling cutter being used to cut a groove that is the same width as the cutter.

Slitting Saw. The slitting saw (see Fig. 13-67) is held on the arbor and is used for what its name implies, the sawing of metal in the milling machine.

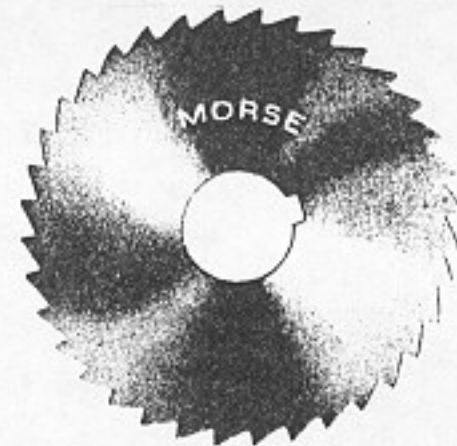
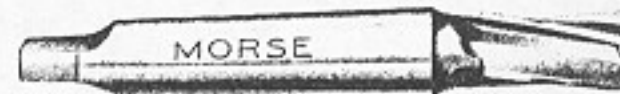


Fig. 13-67. This type of slitting saw is thinner at the center than around the outside edge. This prevents bending of the saw. (Courtesy Morse Twist Drill and Machine Co.)

The work being sawed may be held in the vise or clamped to the table as shown in Fig. 13-68.

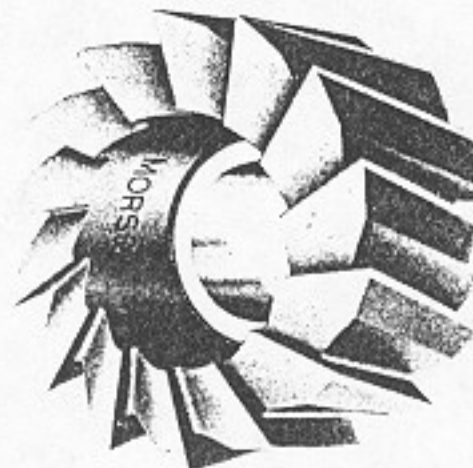
End Mills. There are two types of end mills, the shell end mill and the shank end mill (see Fig. 13-69). Each of these cutters is designed for the same purpose, i.e., to cut two surfaces at the same time, one surface with the end of the cutter and the other with the teeth that are on the outside edge of the cutter. The shell end mill is often used for a facing operation on the milling machine. Fig. 13-70 shows the shank type end mill being used for



(a) Tapered shank end mill.



(b) Straight shank end mill.



(c) Shell end mill.

Fig. 13-69. End Mills. (Courtesy Morse Twist Drill and Machine Co.)

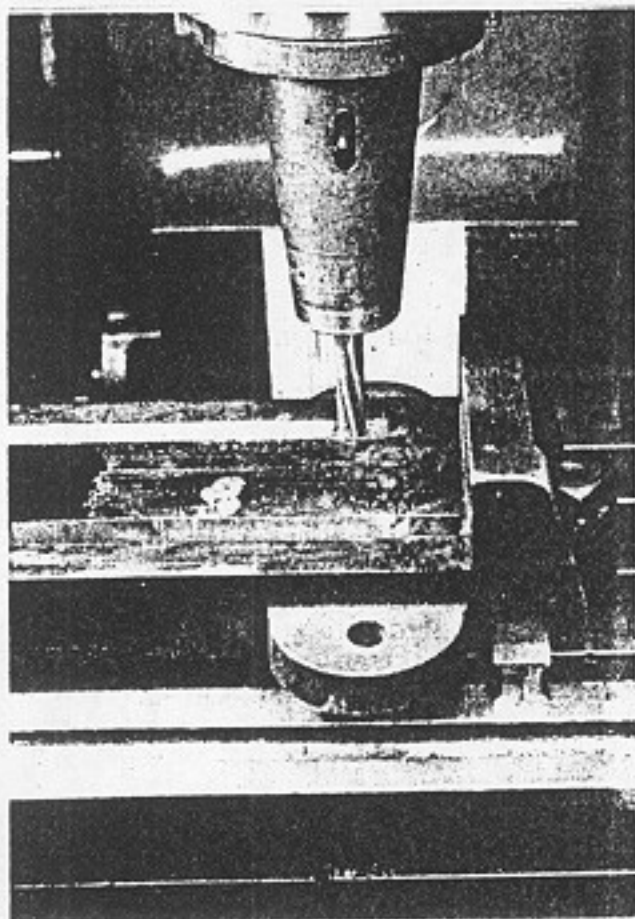


Fig. 13-70. The shank end mill is held in an adapter that fits into the spindle socket of the milling machine.

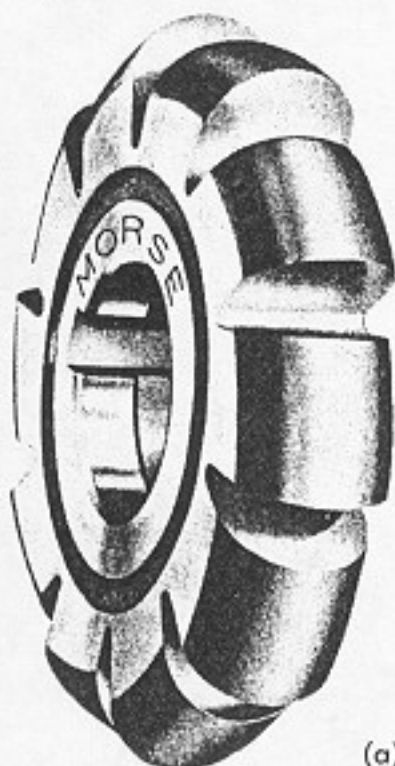
internal milling. This milling cutter may also be used for the machining of internal or external irregular surfaces.

Angular and Form Cutters. The angular and form cutters shown in Fig. 13-71 are single purpose cutters. They will only duplicate the angle or the form of the cutter.

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Questions

1. Explain the reason for using a coolant when sawing metal with the power hack saw.
2. Why should you wear goggles when grinding?
3. What causes the metal to become hot when being ground?
4. What is the purpose of dressing a grinding wheel?
5. How can you tell the sizes of drills?
6. Name the tool that is used to hold straight shank drills.
7. Explain two methods of safely holding work that is being drilled at the drill press.
8. Explain back rake, side rake, front clearance, and side clearance as applied to a lathe tool bit.
9. Why must you have the centers aligned when straight turning on a lathe?



(a)



(b)

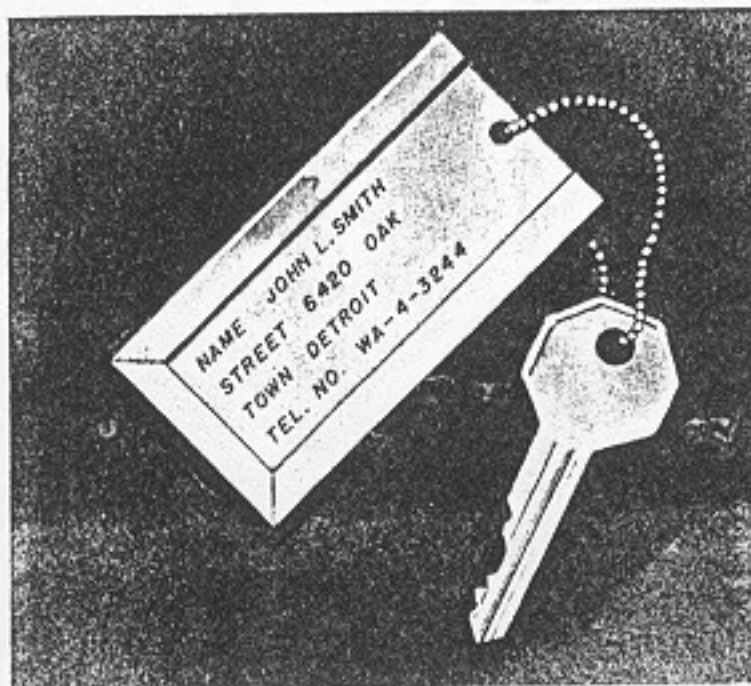
Fig. 13-71. Angular and Form Milling Cutters. (a) Angle cutter. (b) Form cutter. (Courtesy Morse Twist Drill and Machine Co.)

10. What is meant by facing in a lathe?
11. What is shoulder turning?
12. What is taper turning?
13. What is straight turning?
14. Why is it necessary to drill and counter-sink work centers?
15. What is the easiest method of setting a tool bit on center?
16. Explain the two methods of offsetting the tailstock for cutting a taper.
17. Why is it sometimes better to drill holes in a lathe than at the drill press?
18. Why should the operator wear goggles when operating a shaper?
19. Explain the three methods used for leveling the work held in the shaper vise or table.
20. Name four machining operations that are done on the shaper.
21. What is slab milling?
22. What two types of milling machines are in general use?
23. Explain the meaning of feed.
24. Explain the meaning of speed.
25. Name three methods of holding work on the milling machine table.

192

PROJECTS

Note: Dimensions in diagrams are in inches.



*Key Chain
Identification
Tag*

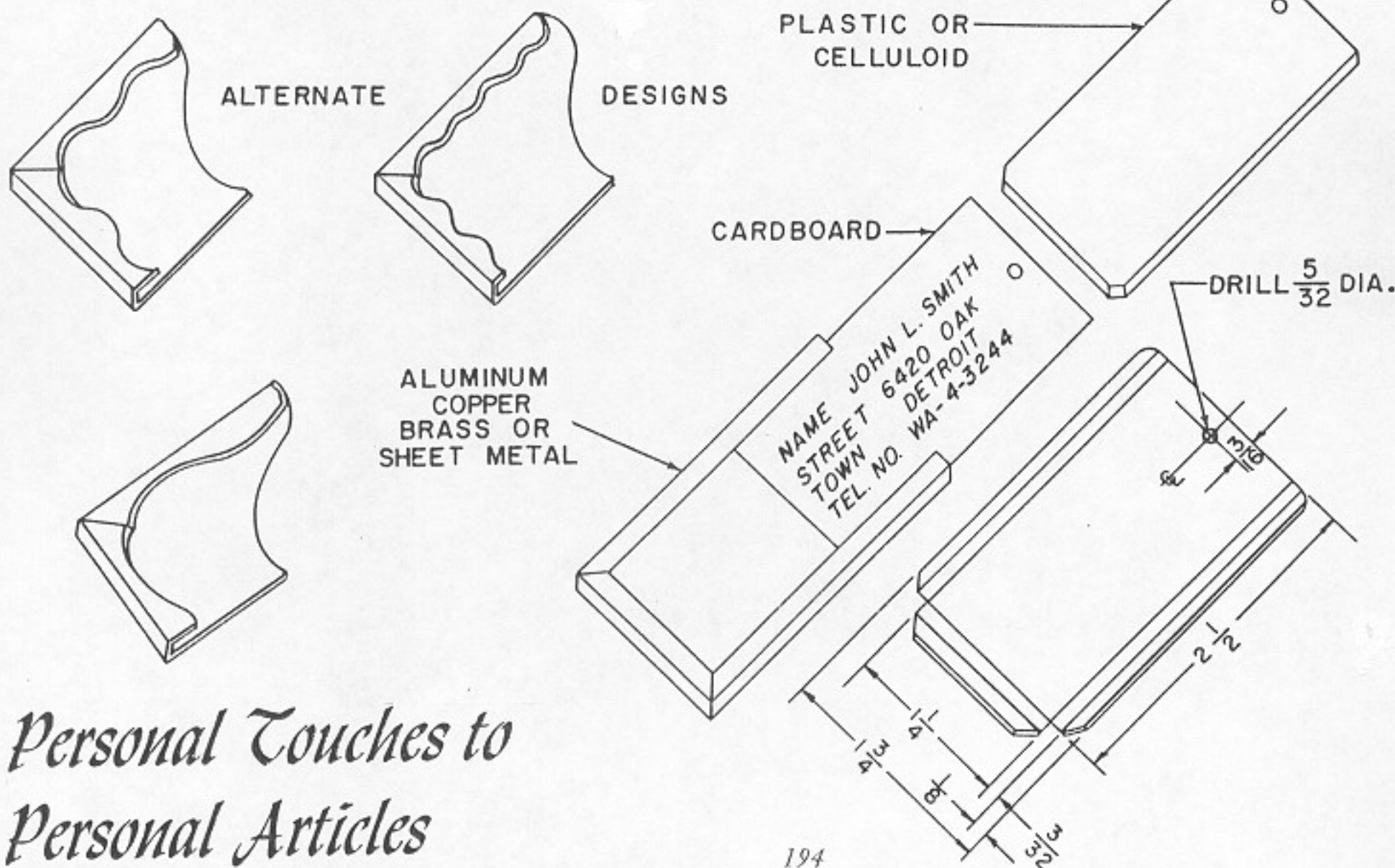
Keys are usually carried on a chain or loose in the owner's pocket or pocketbook. An identification tag makes certain that loose keys will be kept on a chain with it, and makes the keys easier to find. If the keys are lost, the tag makes it easy for the finder to return them to the owner. Remember, care in making the tag will result in an attractive piece of work. (Courtesy Howard N. Mose, Detroit Public Schools, Detroit, Mich.)

3692 193 Reference to Operations in Text

Layout	pages 17-23
Cutting Sheet Metal	page 36
Soldering	pages 73-77
Drilling	page 152
Finishing	pages 90 and 103

Material

1 piece 20-gage sheet metal, 1 $\frac{3}{4}$ " x 2 $\frac{3}{4}$ "



Personal Touches to Personal Articles

A monogram makes a good decoration and serves the practical purpose of identifying your belongings. Do you have a tool box, a bicycle, or some other personal object that you would like to mark as yours? The initial of your name can be etched on a small piece of metal and soldered or riveted to the object you wish to identify. (Courtesy Clyde P. Luttrell, Allen Park High School, Allen Park, Mich.)

Reference to Operations in Text

Cutting Sheet Metal	page 36
Layout	pages 17-23
Etching	page 93
Piercing	page 33
Drilling	page 152
Polishing	page 89
Finishing	pages 90 and 103

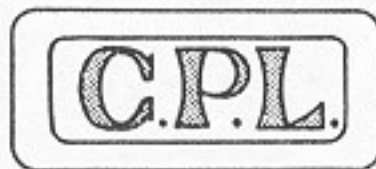
Material

1 piece copper, brass, or aluminum to fit the design being used

SUGGESTED USES



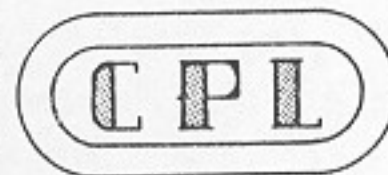
LUGGAGE IDENTIFICATION



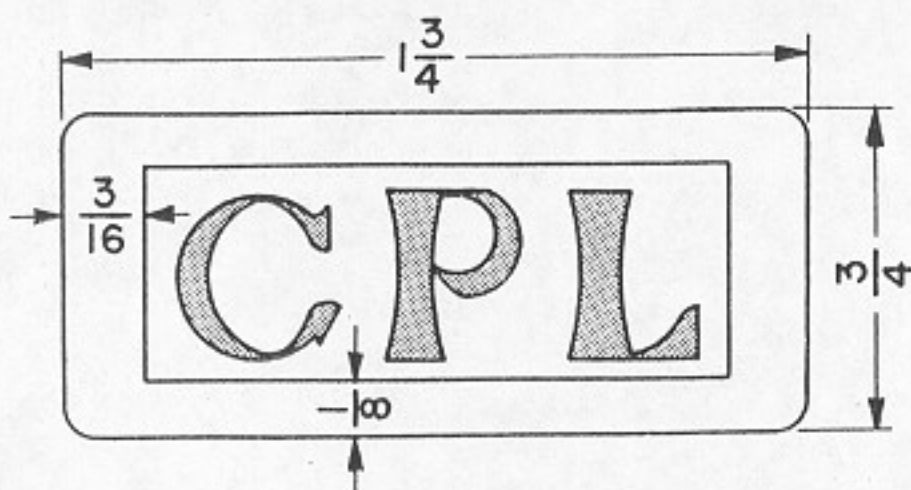
PAPER WEIGHT



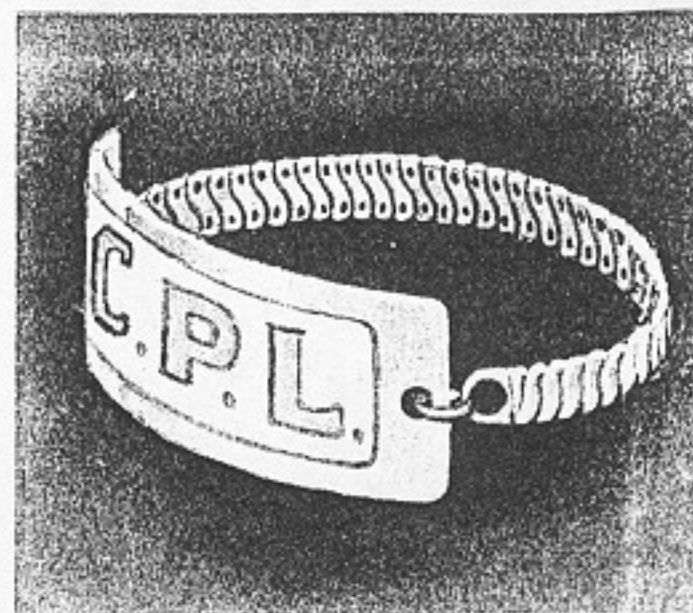
FASTEN TO CAR DOOR



FASTEN TO BICYCLE FRAME



195

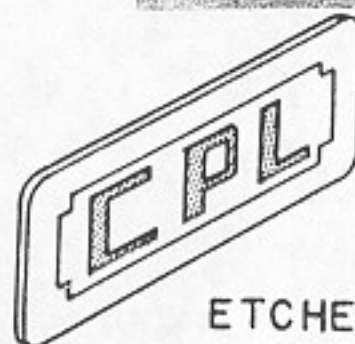


IF TO BE FASTENED WITH RIVET
OR SCREWS, DRILL $\frac{3}{32}$ HOLE, CENTER
EACH END.

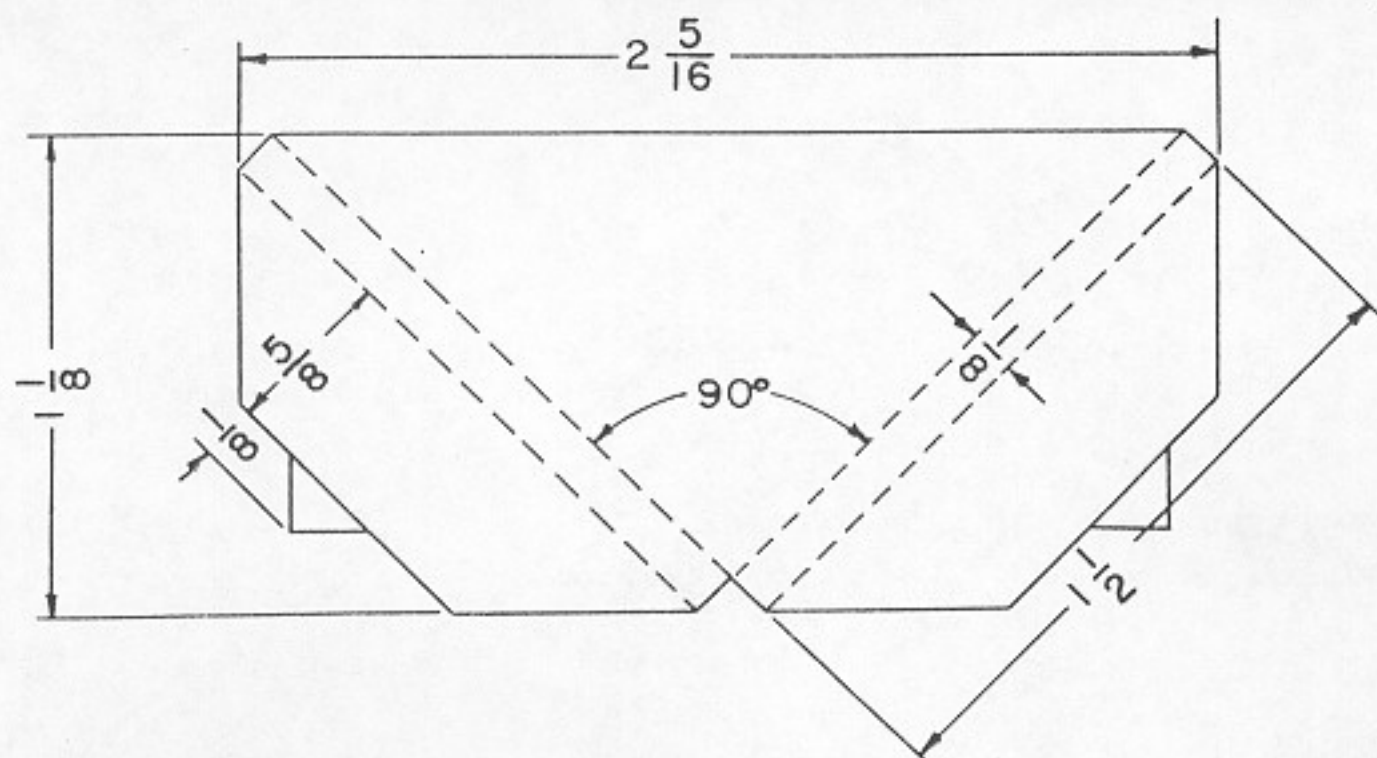
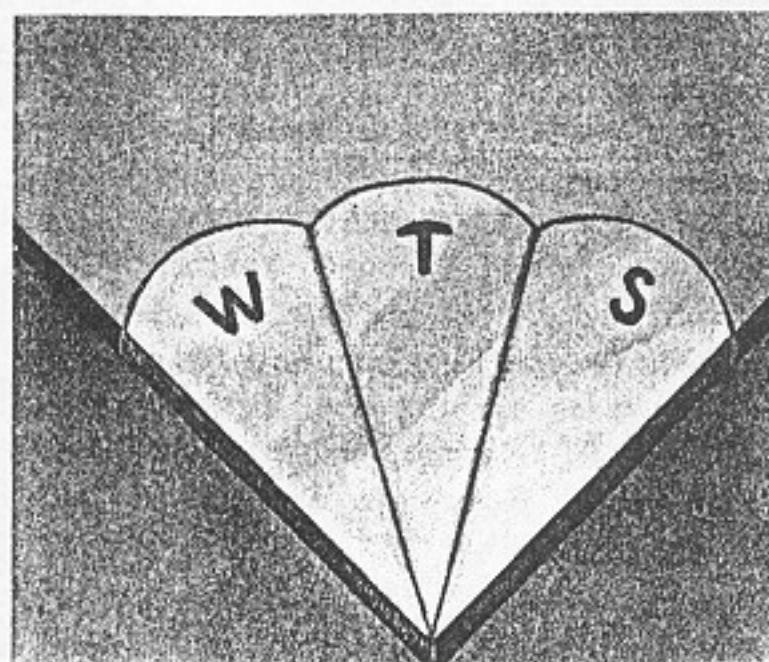
Metal Corners for Worn Loose-Leaf Notebook Covers

196

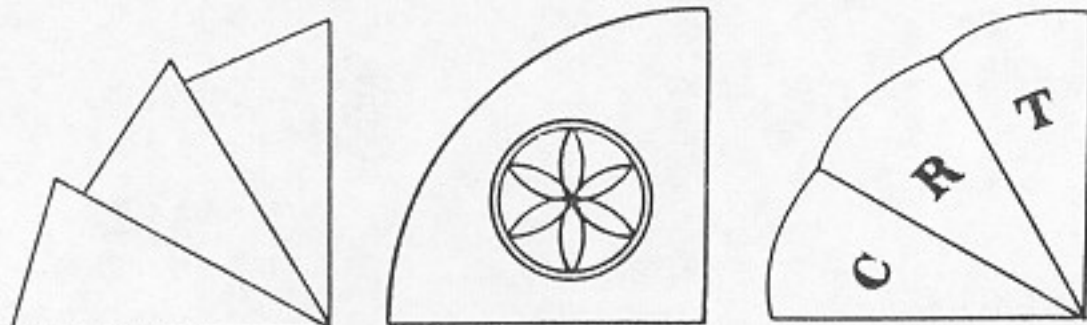
Do you have an old notebook cover that is worn and has frayed corners, although it is otherwise in good condition? Here is a suggestion that will help you to improve its looks and lengthen its life. Four metal corners and some paint can turn the old notebook into a useful article that looks better than new. (Courtesy Clyde P. Luttrell, Allen Park High School, Allen Park, Mich.)



ETCHED

CUT OUT
NON-SHADED
AREA

ALTERNATE DESIGNS 197



ETCH DESIGN

STAMP LETTERS
CHASE LINES

Reference to Operations in Text

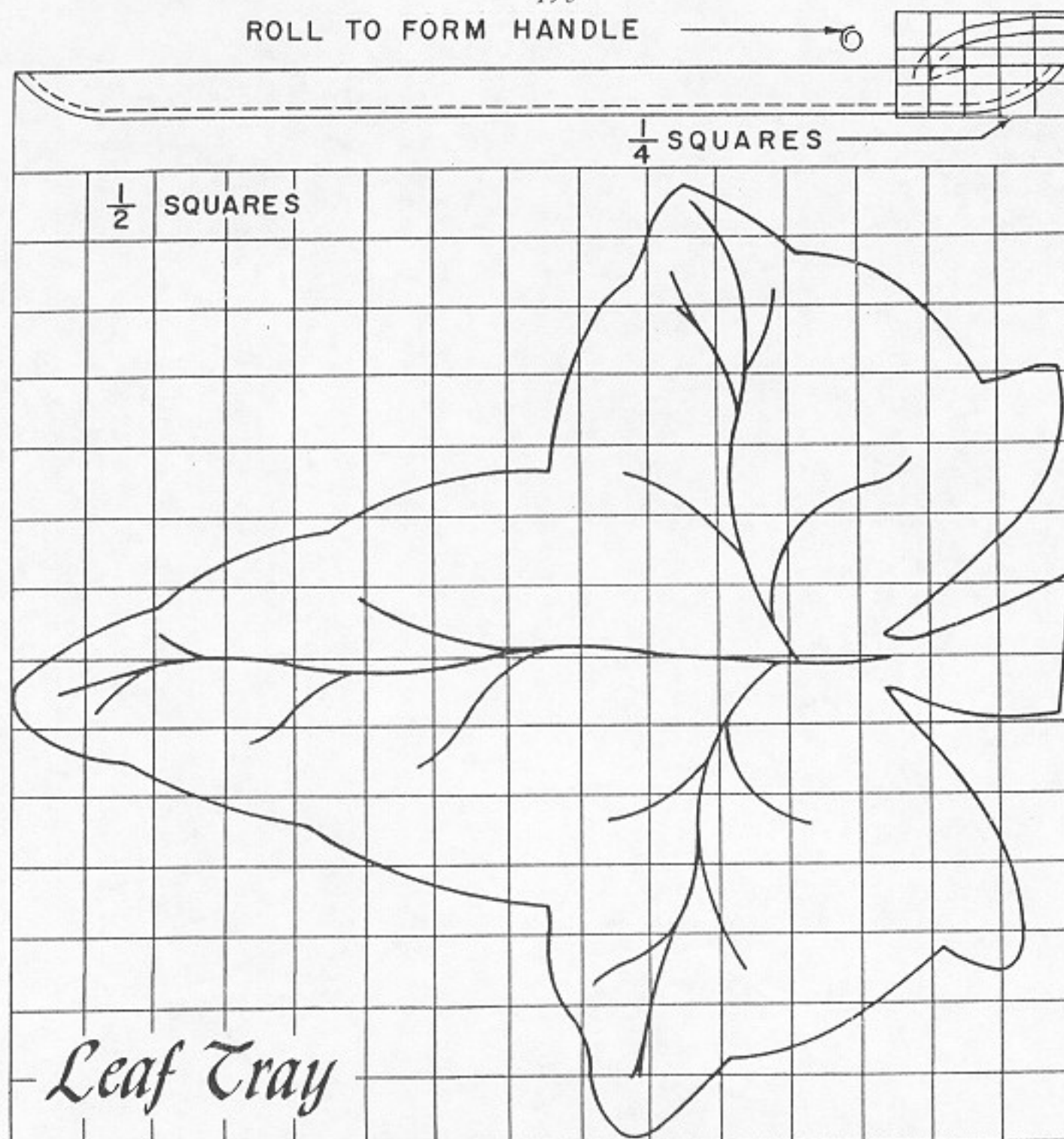
Layout	pages 17-23
Cutting Sheet Metal	page 36
Using the Jeweler's Saw	page 32
Etching	page 93
Polishing	page 86
Finishing	pages 90 and 103

Material

4 pieces 22- to 26-gage sheet metal, copper, brass,
or aluminum, $1\frac{1}{8}$ " x $2\frac{3}{4}$ "

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ROLL TO FORM HANDLE

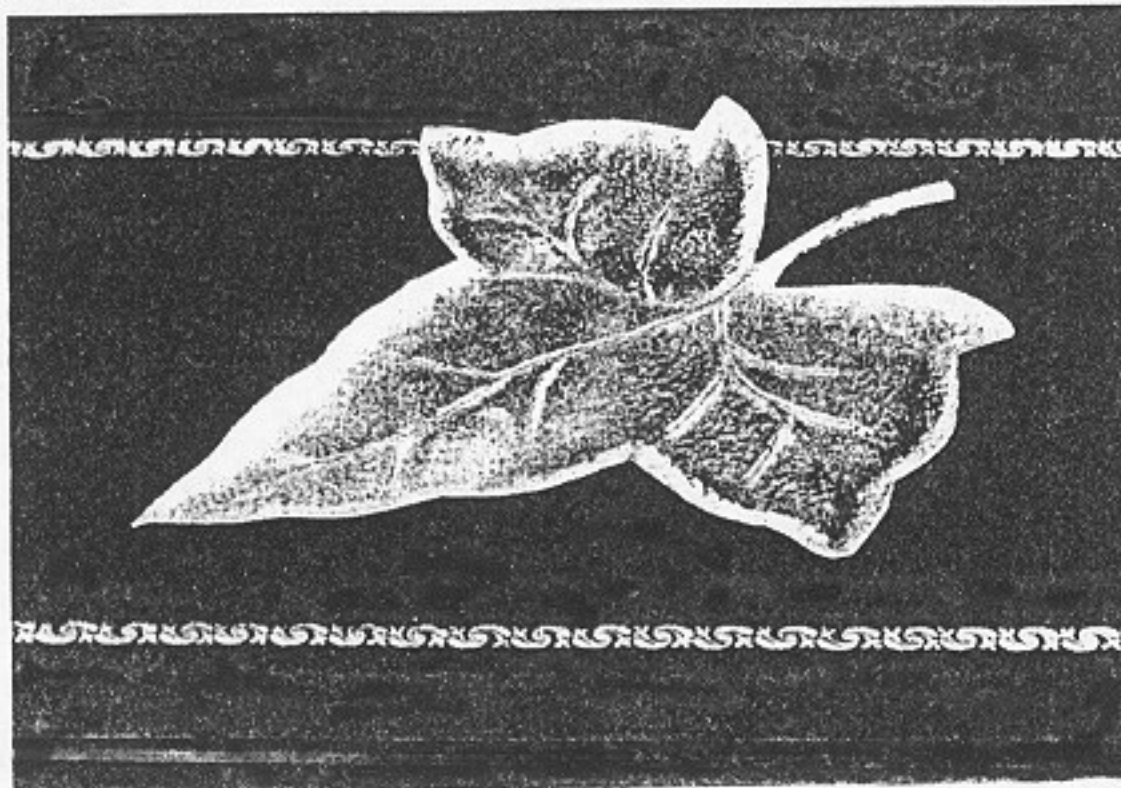


You will find this tray in the form of a leaf to be a most attractive art metal project. It has a distinctive look. Through careful planning you will be pleasantly surprised at the ease with which you can make the leaf tray. Another surprising thing about this project is that it can be made from a relatively small piece of copper or brass.

Reference to Operations in Text

199

Pattern	page 27
Cutting Sheet Metal	page 36
Hammer Marking	page 96
Chasing	page 97
Polishing	page 86
Finishing	pages 90 and 103



Materials

1 piece 18-gage brass, copper, or aluminum, 7" x 7½"

200

Candy Dish

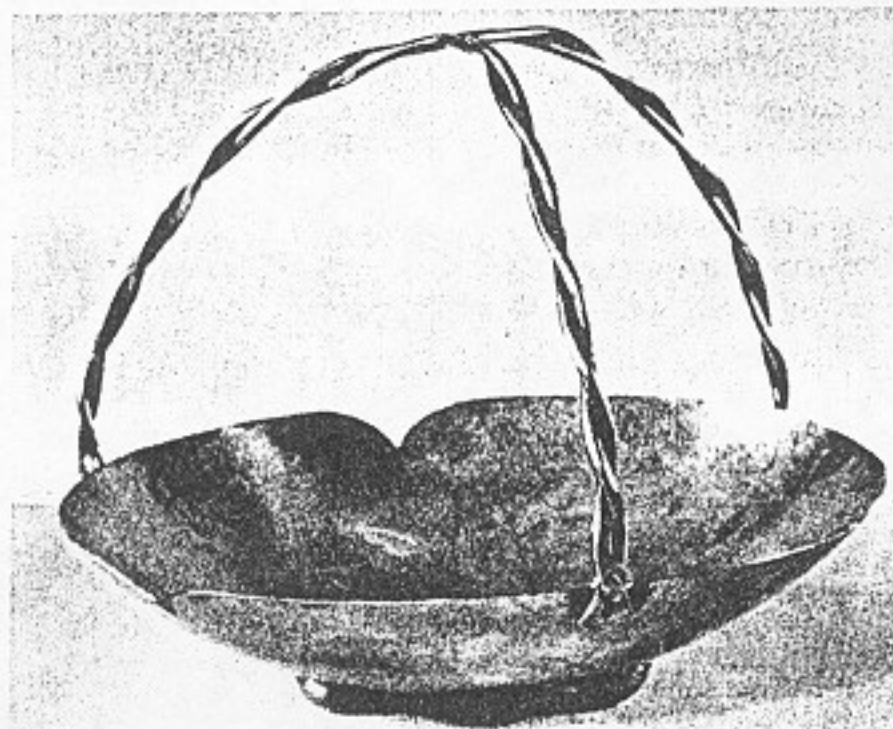
Hammered bowls of the kind shown here have a wide variety of uses. Some people use them for candy, for nuts, or just for appearance. When making a bowl of this kind, you should give thought to the kind of metal to be used, for copper, brass or aluminum is more attractive when placed in the proper surroundings.

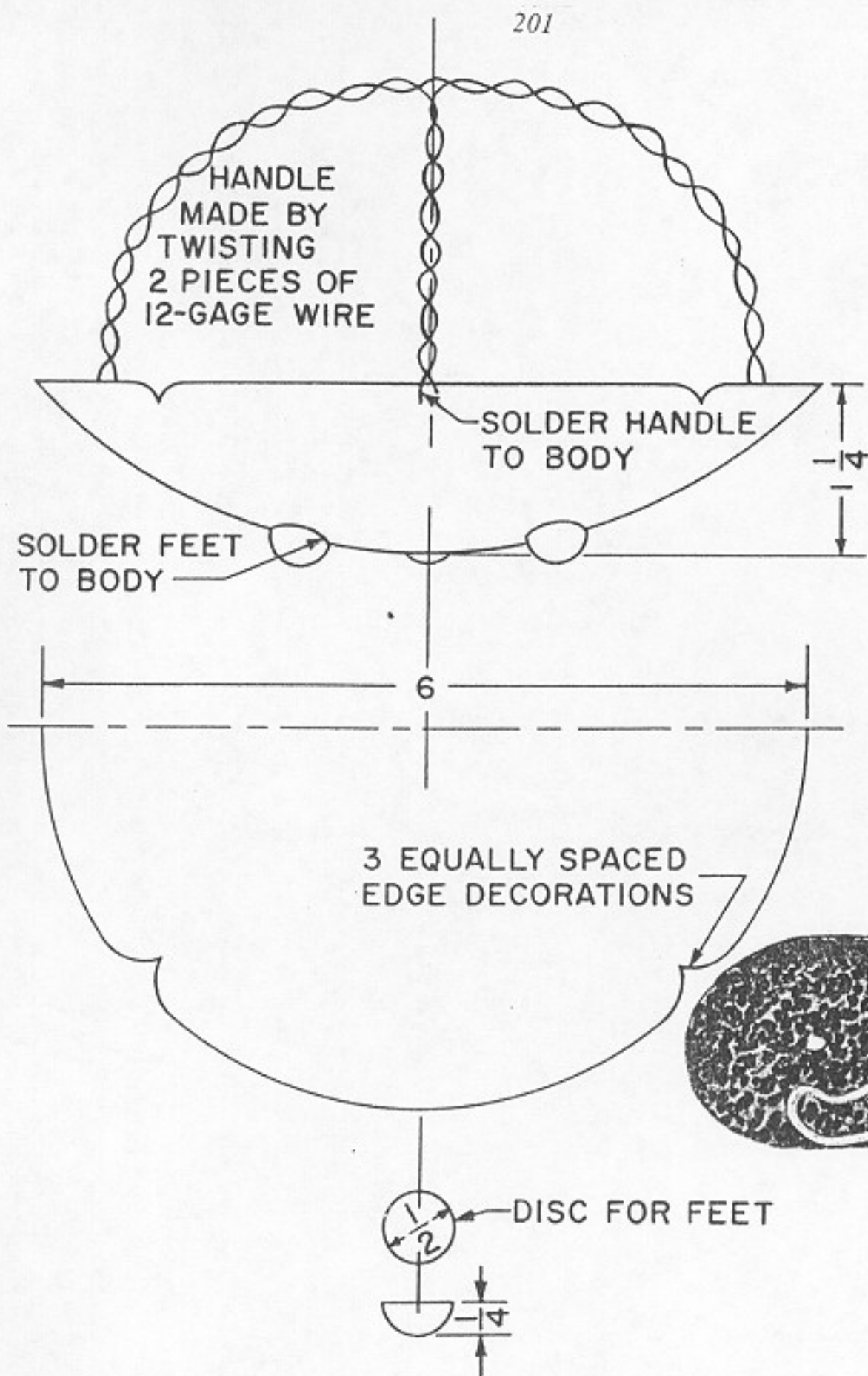
Reference to Operations in Text

Scribing a Circle	page 23
Raising	page 51
Annealing Copper and Brass	page 52
Jeweler's Saw	page 32
Soldering	pages 73-77

Material

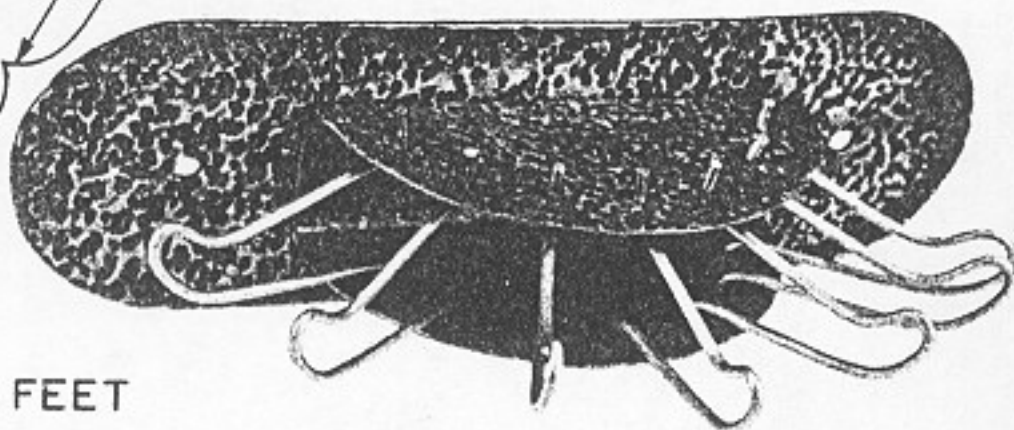
- 1 piece 18-gage copper or brass, 6" diameter
- 3 pieces Number 12 copper or brass wire, 10" long
- 3 20-gage discs, copper or brass, ½" diameter





202

Necktie Hanger



Your favorite necktie is difficult to find if it is hung over a clothes hook or a rod. There are necktie hangers that are designed so that, though only two or three neckties are hung on a single rod, the hangers hold a large number of ties. The one shown here is of that design. (Courtesy Arthur D. Anderson, Oxford Junior High School, Dearborn, Mich.)

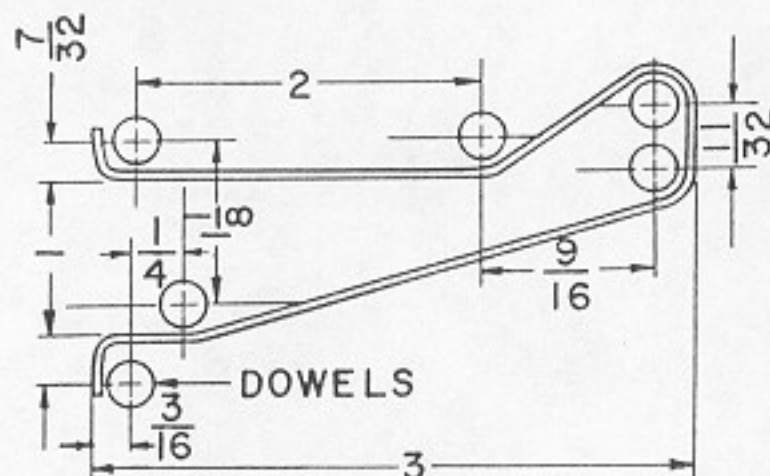
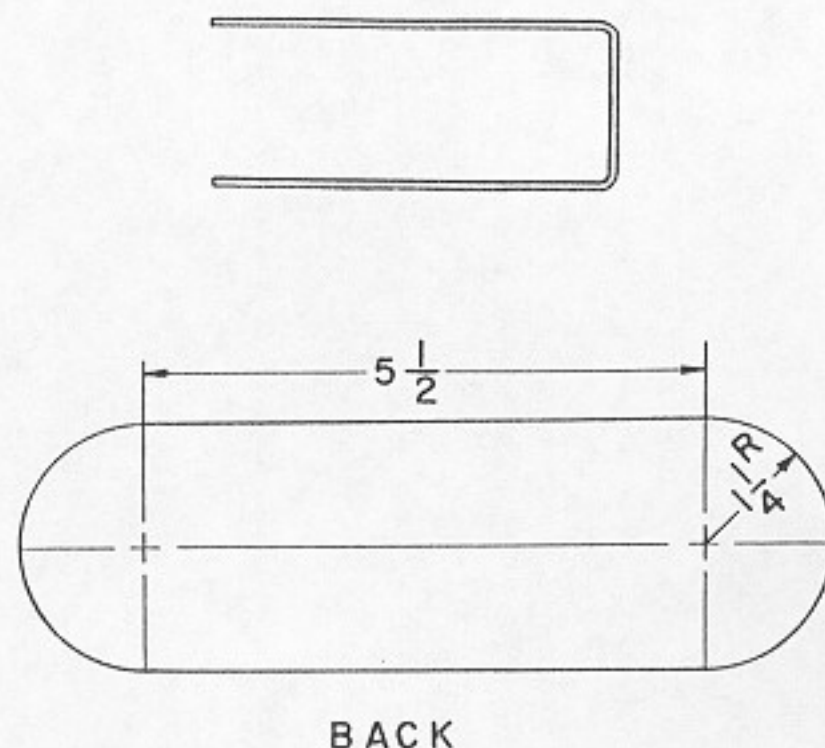
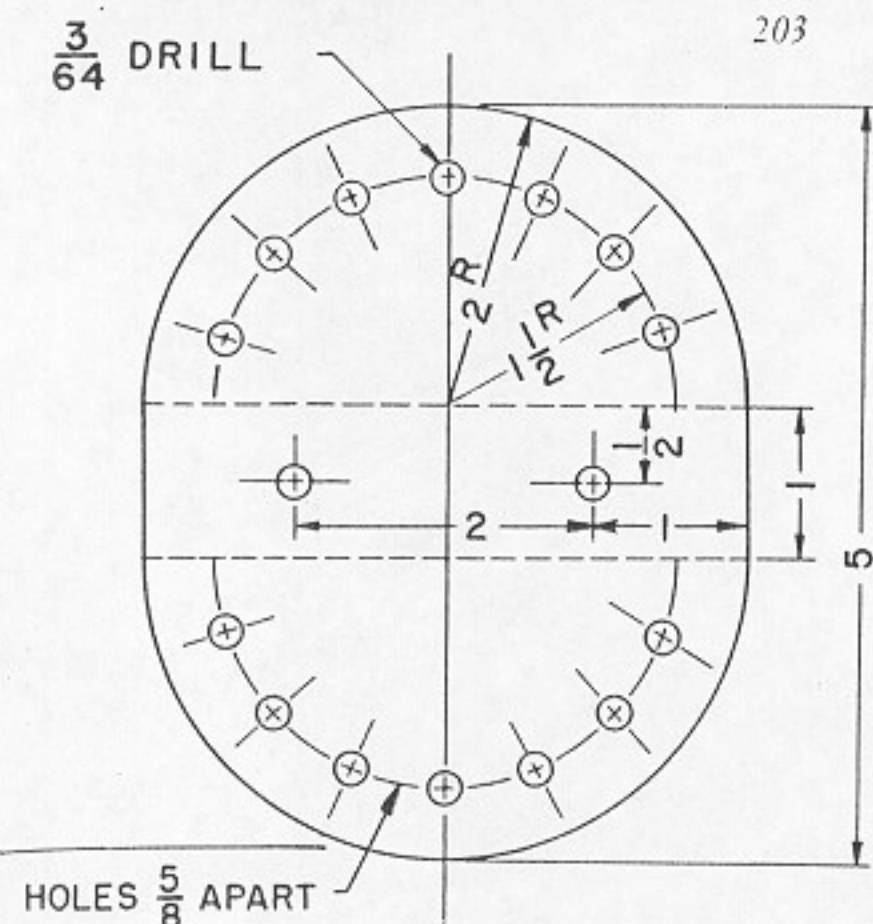
Reference to Operations in Text

Layout	pages 17-23
Cutting Sheet Metal	page 36
Hammer Marking	page 96

Filing	pages 40, 41
Drilling	page 152
Riveting	page 80
Forming Wire	page 56
Polishing	page 86
Finishing	pages 90 and 103

Material

- 1 piece 18- or 20-gage sheet steel, copper, brass, or aluminum or 1 piece 2½" x 7½" wood or plastic
- 7 pieces 3/32" x 7" brazing rod or wire



JIG FOR TIE HANGERS MADE BY DRIVING FINISHING NAILS INTO HARD WOOD. SPACE NAILS FOR DESIRED BENDS. A METAL BASE MAY BE USED. DRILL HOLES TO FIT METAL PINS BEING USED.

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Table Lamp

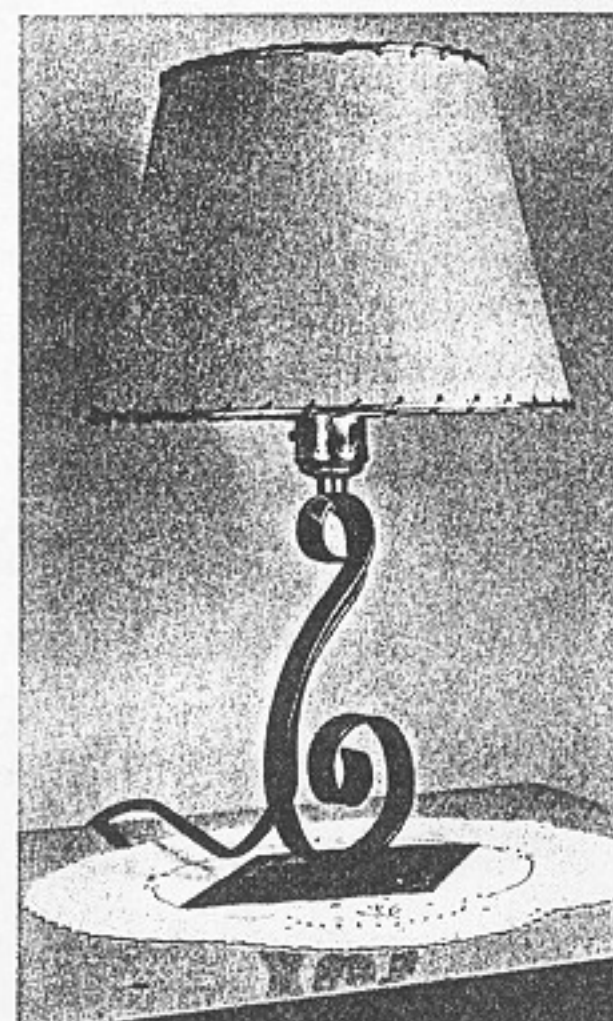
The table lamp may be used in the living room, a hall, or your own room, or as a desk lamp. Its shape and color make it fit into almost any room. The type of shade should be governed by where the lamp will be used. (Courtesy, Edsell Evans, Detroit Public Schools, Detroit, Mich.)

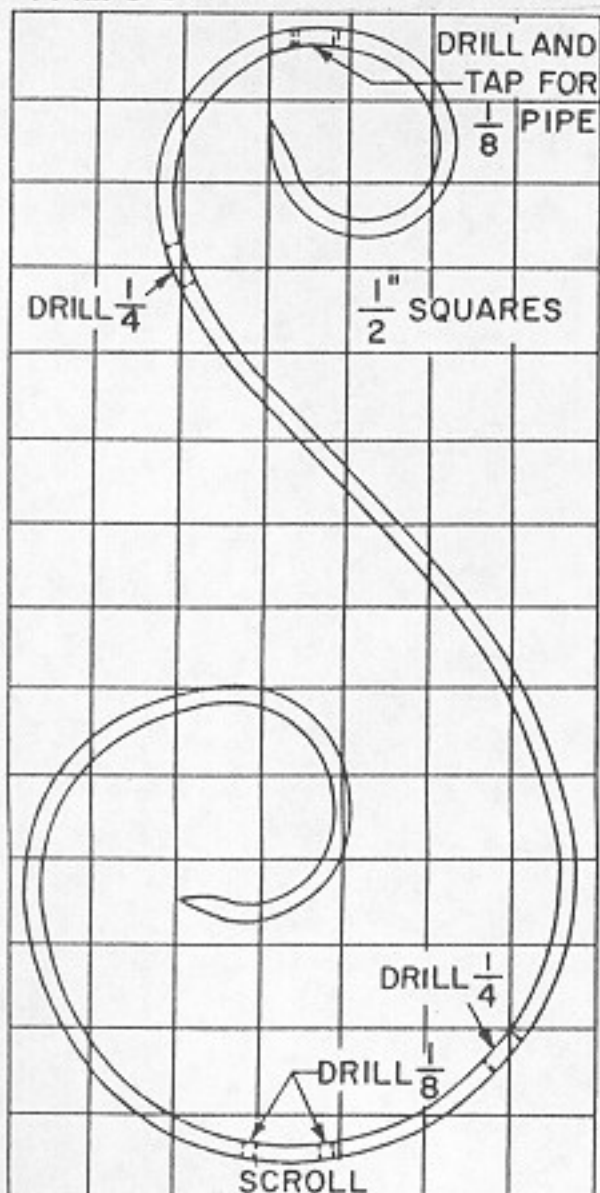
Reference to Operations in Text

Layout	pages 17-23
Raising Metal	page 51
Hammer Marking	page 96
Forming Band Iron	pages 119, 120, 121
Drilling	page 152
Riveting	pages 78, 80, 122

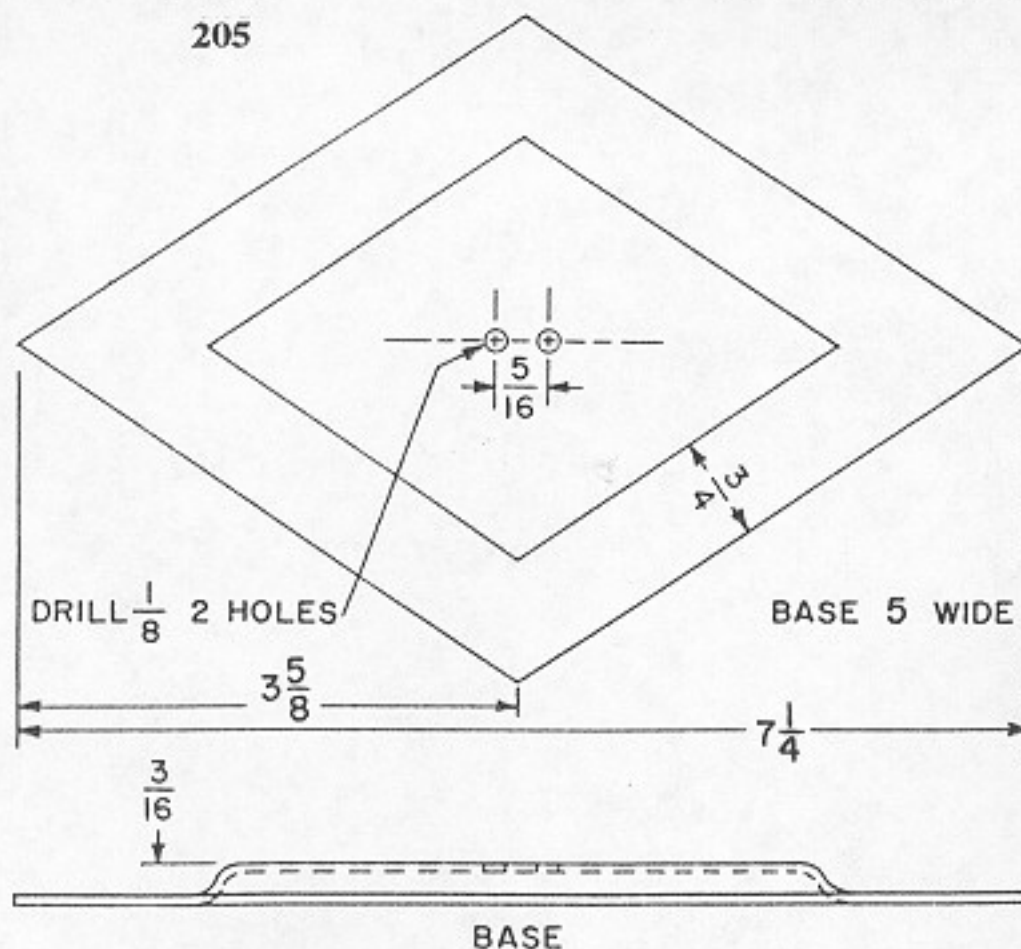
Material

- 1 piece 1/8" x 1/2" x 17" band iron
- 1 piece 18-gage sheet metal, 4 1/8" x 6"
- 1 push-button lamp socket and wire

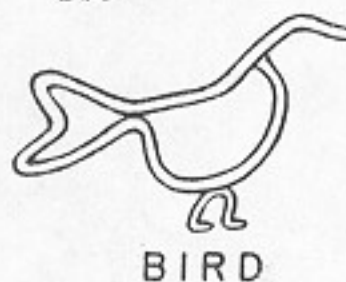
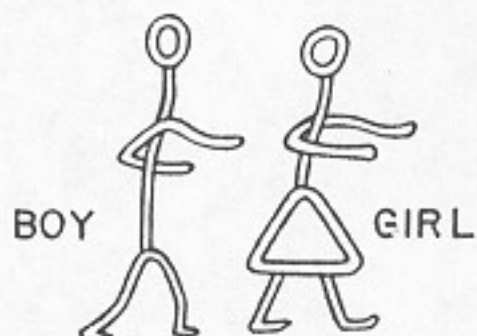




205



206



THESE FIGURES TO
HANG ON WALL

Saucy Figures

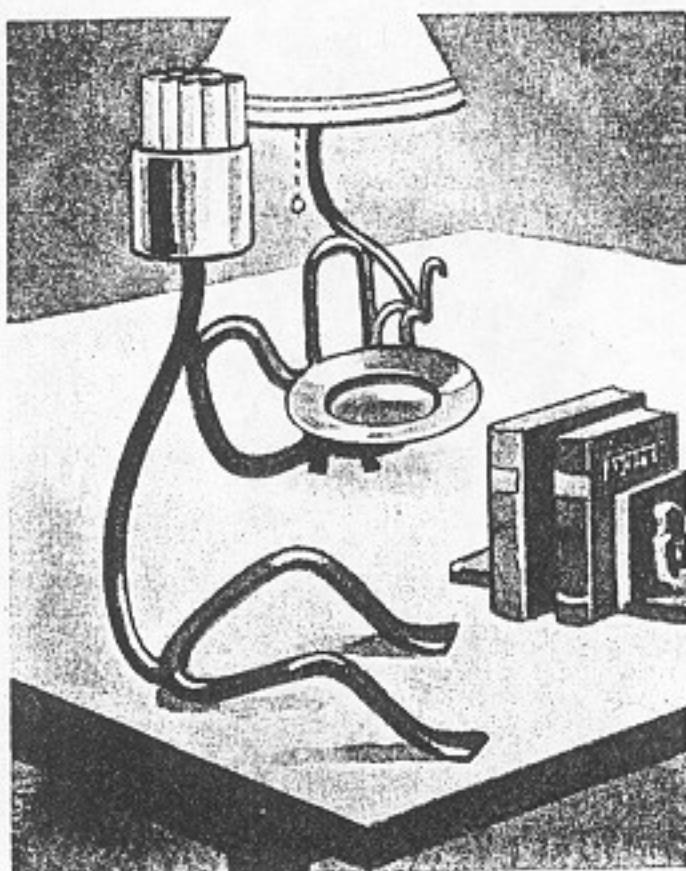
Saucy figures are interesting to make, because they provide a means for you to use your own imagination. If you do not want to make the man or the dog lamp, maybe you can suggest a design of your own.

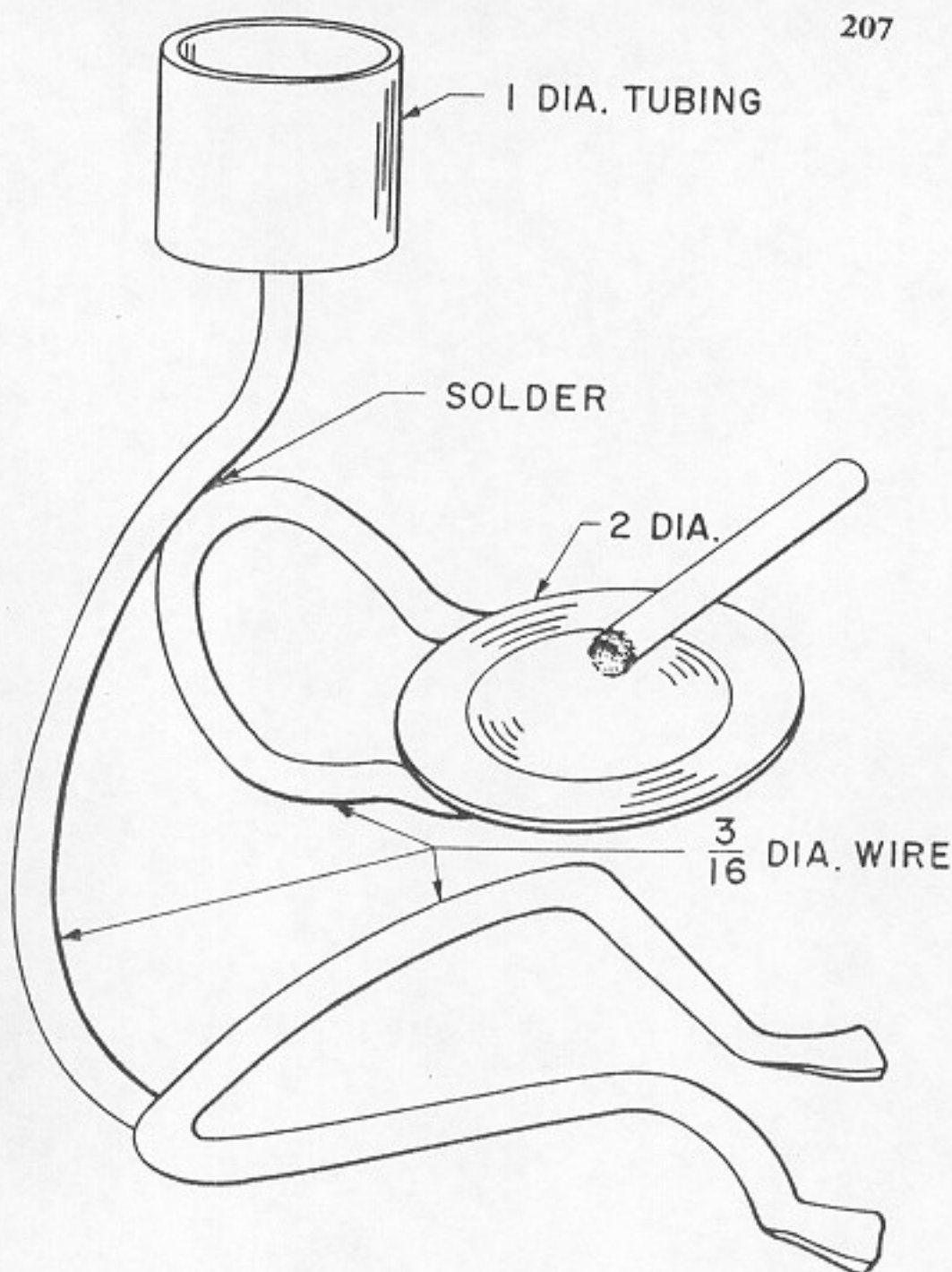
Reference to Operations in Text

Forming Wire	page 56
Raising or Metal Spinning	page 51 or 105
Soldering or Welding	page 73 or 80
Finishing	page 90 or 103

Material

$\frac{1}{8}$ ", $\frac{3}{16}$ ", or $\frac{1}{4}$ " round hot rolled steel. Length varies for each figure made.



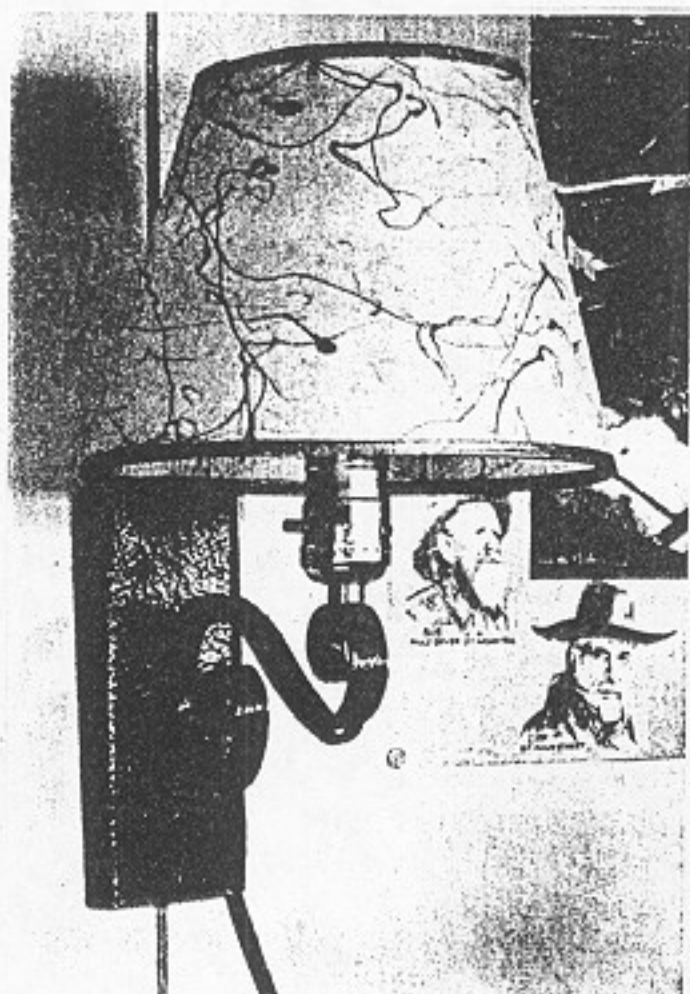


ALTERNATE SUGGESTIONS:

TABLE LAMP (MAKE FIGURE 10" HIGH)

USE SMALL FLOWER POT
INSTEAD OF ASH TRAY

CANDLE HOLDER (MAKE FIGURE
OF 8" HIGH TUBING TO FIT
BASE OF A CANDLE)



Pin-up Lamp

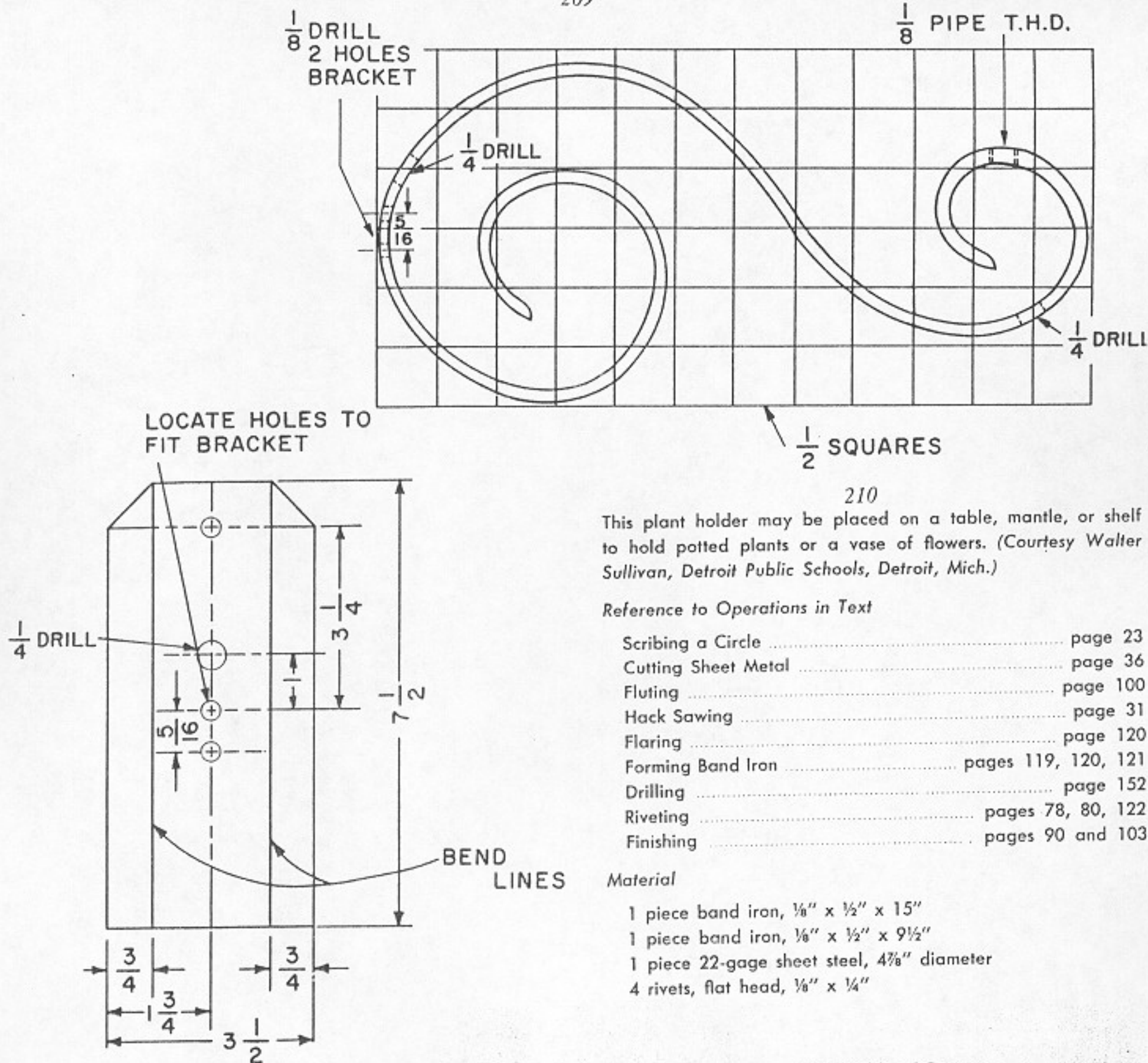
A variety of lamps can be used to make any home more attractive. This lamp can be hung on the wall above your bed or near your favorite chair, provided there is an electric outlet nearby. (Courtesy Edsell Evans, Detroit Public Schools, Detroit, Mich.)

Reference to Operations in Text

Layout	pages 17-23
Hack sawing	page 31
Hammer Marking	page 96
Forming Band Iron	pages 119, 120, 121
Drilling	page 152
Tapping	page 44
Riveting	pages 78, 80, 122
Finishing	pages 90 and 103

Material

- 1 piece $\frac{1}{8}$ " x $\frac{1}{2}$ " x 17" band iron
- 1 piece 18-gage sheet steel, $3\frac{1}{2}$ " x $7\frac{1}{2}$ "
- 1 push-button lamp socket and wire



210

This plant holder may be placed on a table, mantle, or shelf to hold potted plants or a vase of flowers. (Courtesy Walter Sullivan, Detroit Public Schools, Detroit, Mich.)

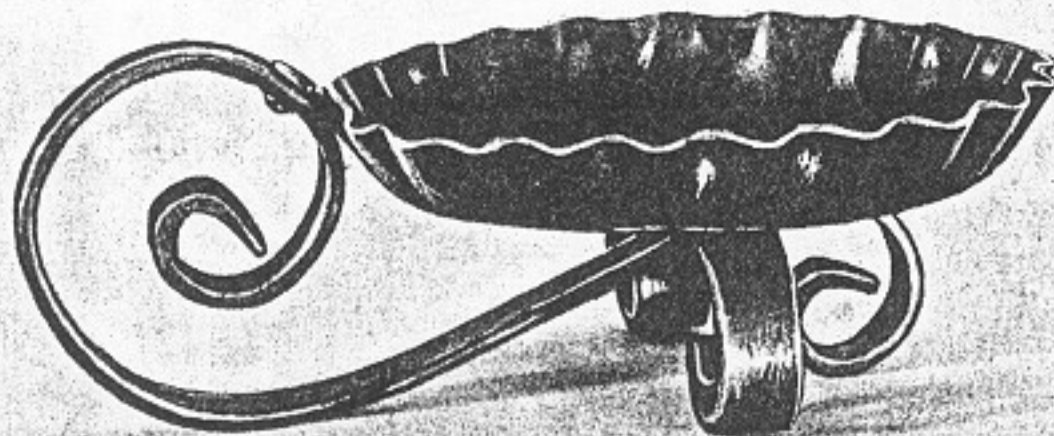
Reference to Operations in Text

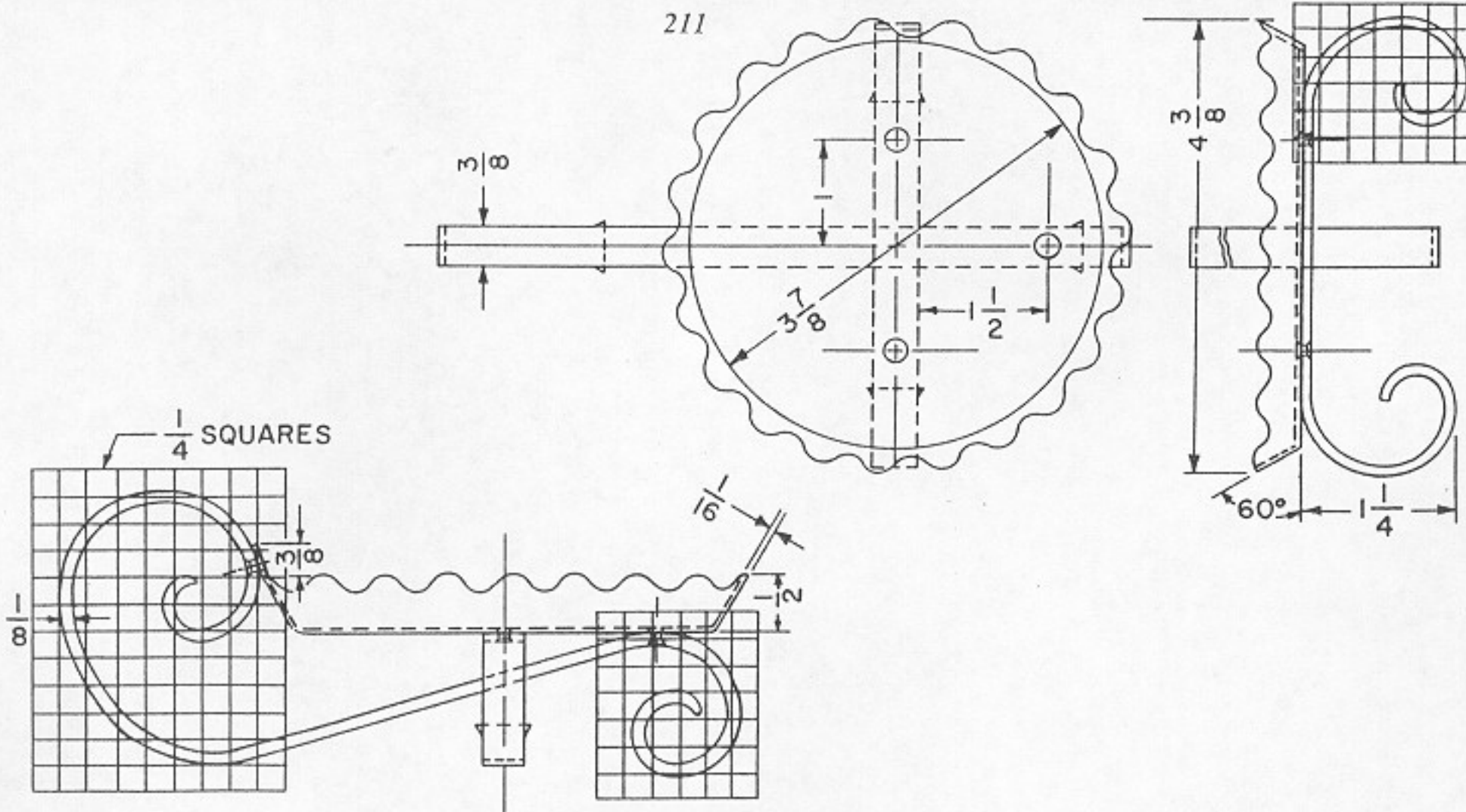
Scribing a Circle	page 23
Cutting Sheet Metal	page 36
Fluting	page 100
Hack Sawing	page 31
Flaring	page 120
Forming Band Iron	pages 119, 120, 121
Drilling	page 152
Riveting	pages 78, 80, 122
Finishing	pages 90 and 103

Material

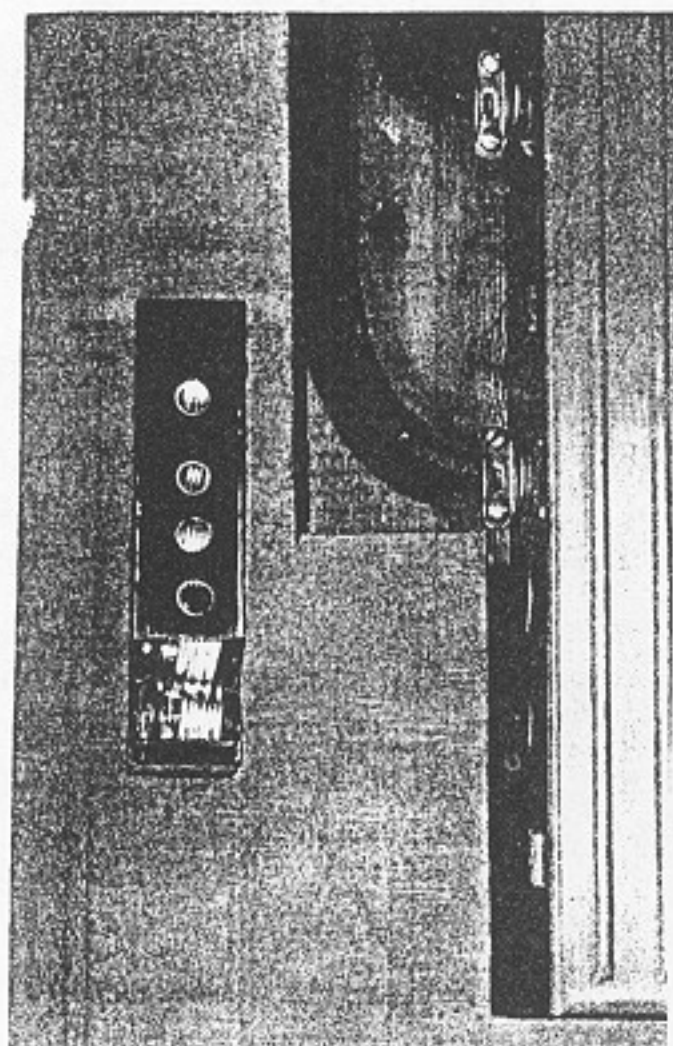
- 1 piece band iron, $\frac{1}{8}$ " x $\frac{1}{2}$ " x 15"
- 1 piece band iron, $\frac{1}{8}$ " x $\frac{1}{2}$ " x 9 $\frac{1}{2}$ "
- 1 piece 22-gage sheet steel, 4 $\frac{7}{8}$ " diameter
- 4 rivets, flat head, $\frac{1}{8}$ " x $\frac{1}{4}$ "

Plant Holder





212



Utility Fuse Box

When a fuse burns out you just have to find another one to take its place. No new fuse, no light. Then again quite often when the fuse burns out, the light by the fuse panel goes out, so you must use matches or a flashlight to try to locate that new fuse. Why not have the fuses located right next to the fuse panel in a metal box so that when you need one you can find it?

Reference to Operations in Text

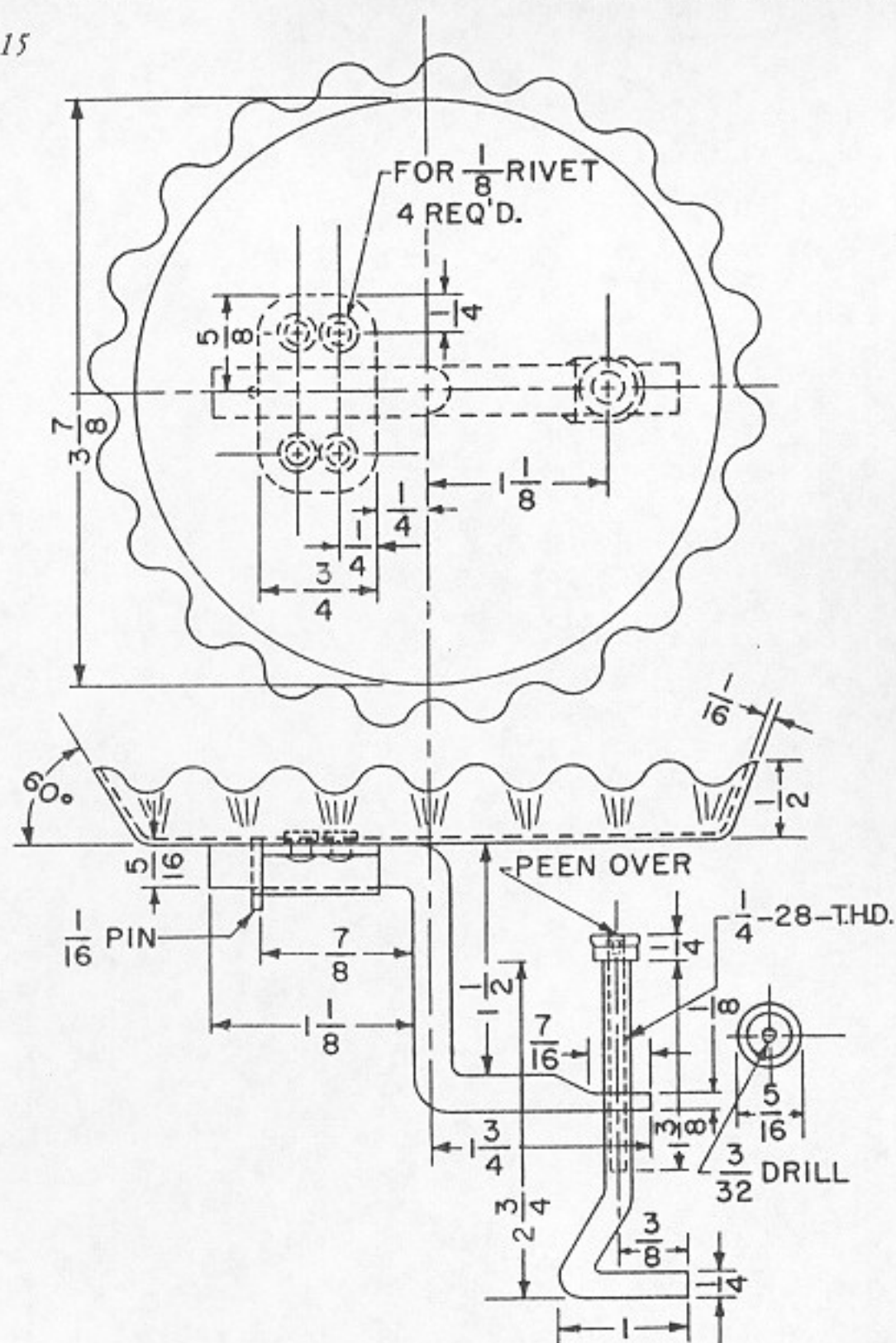
Template	page 27
Using Tinner's Snips	page 36
Punching Holes	page 79
Soldering	pages 73-77

Material

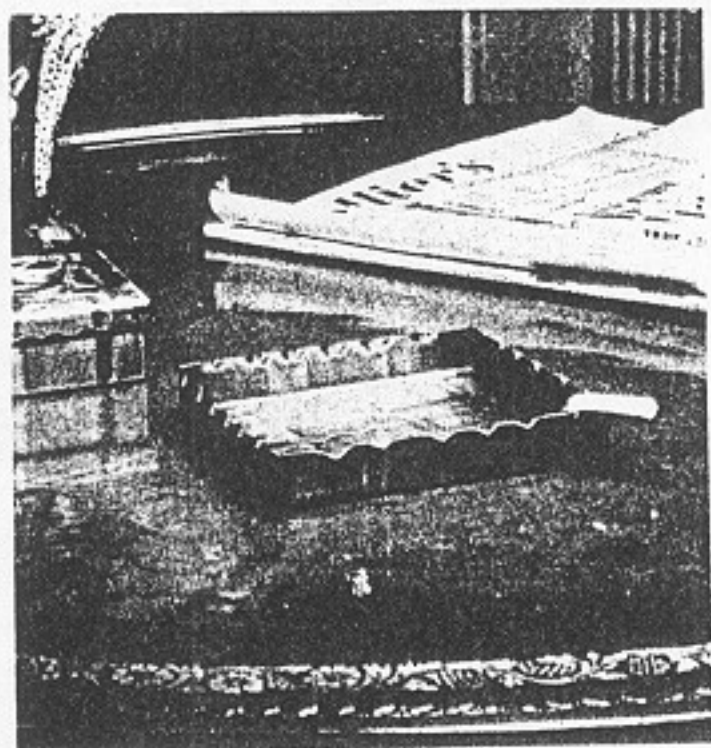
1 piece sheet metal, 5 1/4" x 7 1/4"



Tray: 20-gage sheet metal, 4 $\frac{7}{8}$ " dice
Support: $\frac{1}{4}$ " round C.R.S., 5 $\frac{1}{4}$ " long
Screw: $\frac{1}{4}$ " round C.R.S., 3 $\frac{3}{4}$ " long
Cleat: 20-gage sheet metal, $\frac{7}{8}$ " x 1 $\frac{3}{4}$ "
Pad: $\frac{3}{8}$ " round C.R.S., $\frac{1}{8}$ " long
Two $\frac{1}{8}$ " R.H. iron rivets, $\frac{1}{4}$ " long



Ash Tray



It seems desirable to have ash trays within easy reach about the living room. By choosing a suitable metal and by careful designing, you can make trays that are interesting pieces of decorative art. Do not forget that a nice ash tray always makes a desirable birthday or Christmas present.

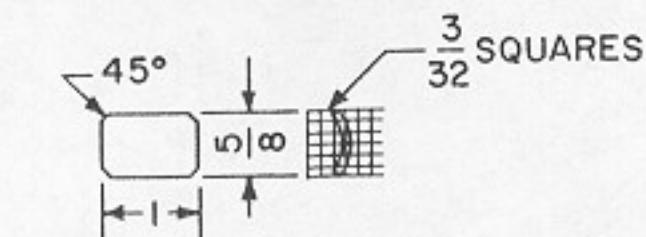
Reference to Operations in Text

Cutting Sheet Metal	page 36
Layout	pages 17-23
Fluting	page 100
Soldering	pages 73-77
Polishing	page 86
Coloring Brown on Copper or Brass	page 103

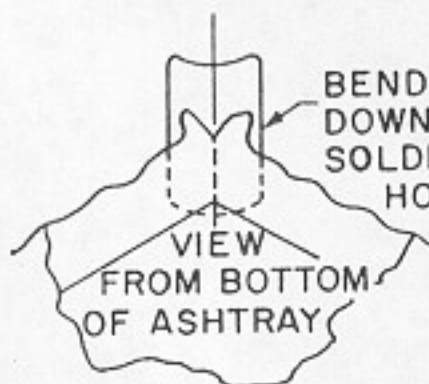
Material

- 1 piece 18-gage copper or brass, 5" x 5"
1 piece 18-gage copper or brass, 3/4" x 1"

217

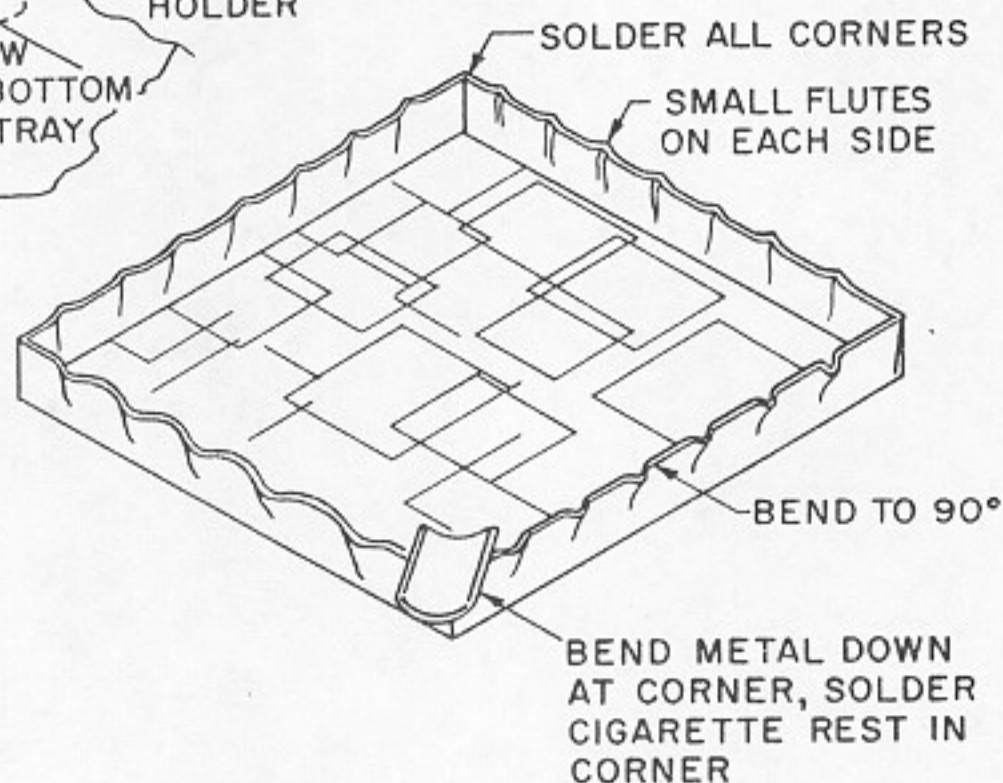


CIGARETTE HOLDER



BEND METAL
DOWN AT CORNER,
SOLDER CIGARET
HOLDER

VIEW
FROM BOTTOM
OF ASHTRAY

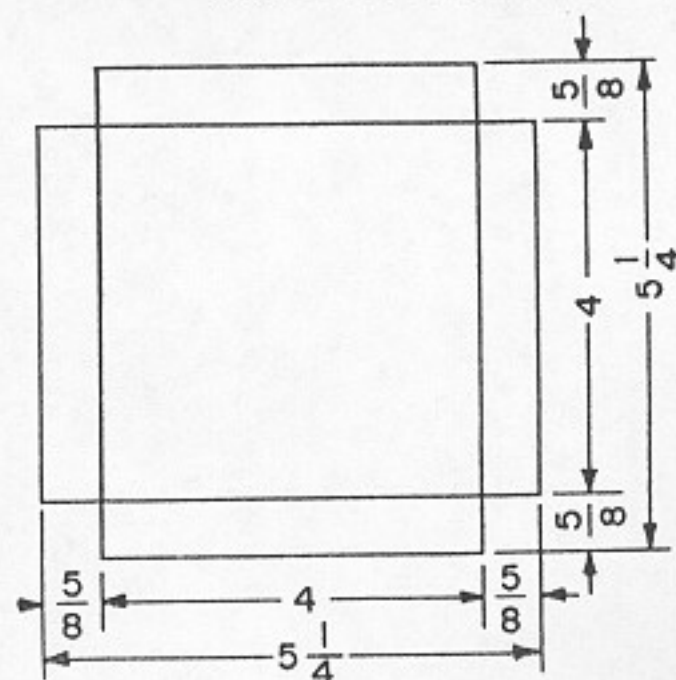


SOLDER ALL CORNERS

SMALL FLUTES
ON EACH SIDE

BEND TO 90°

BEND METAL DOWN
AT CORNER, SOLDER
CIGARETTE REST IN
CORNER



BODY

218

Cigarette Box

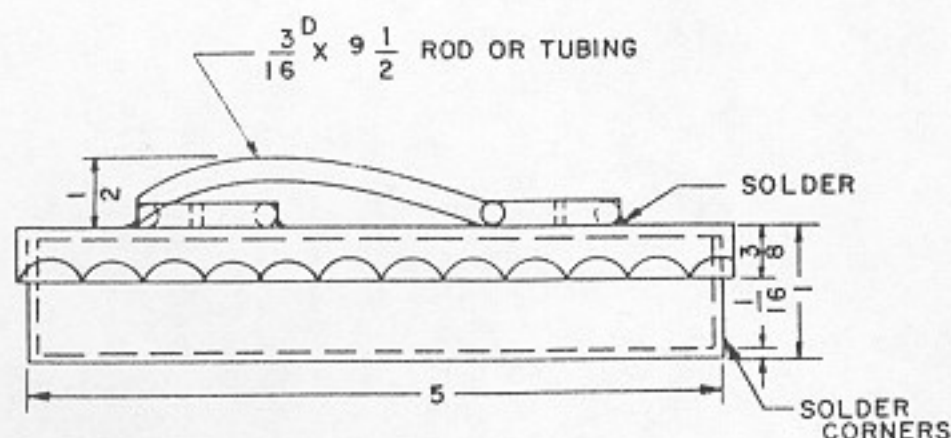
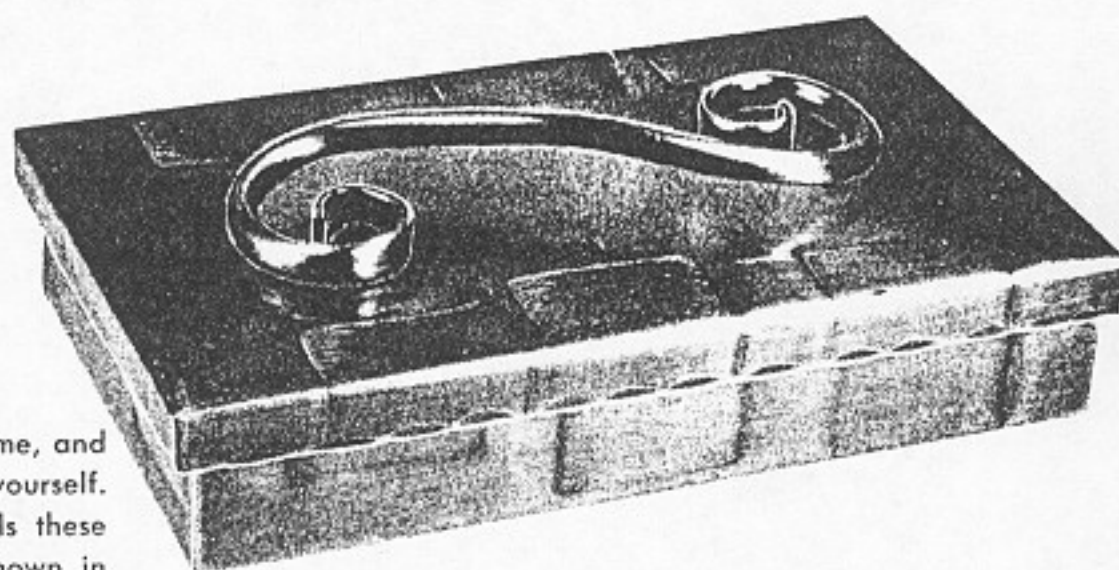
A gift that is useful as well as beautiful is always welcome, and it is certain to be doubly appreciated if you make it yourself. A nicely designed and well made cigarette box fulfills these requirements, especially if paired with the ash tray shown in the preceding project.

Reference to Operations in Text

Layout	pages 17-23
Cutting Sheet Metal	page 36
Decorating Metal Surfaces	pages 96-100
Coloring Brown on Brass or Copper	page 103

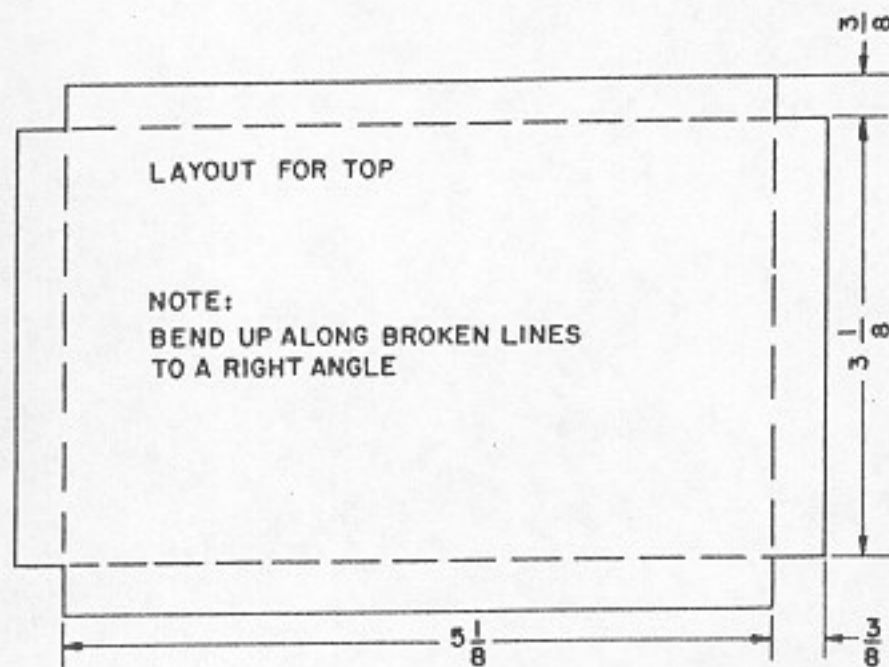
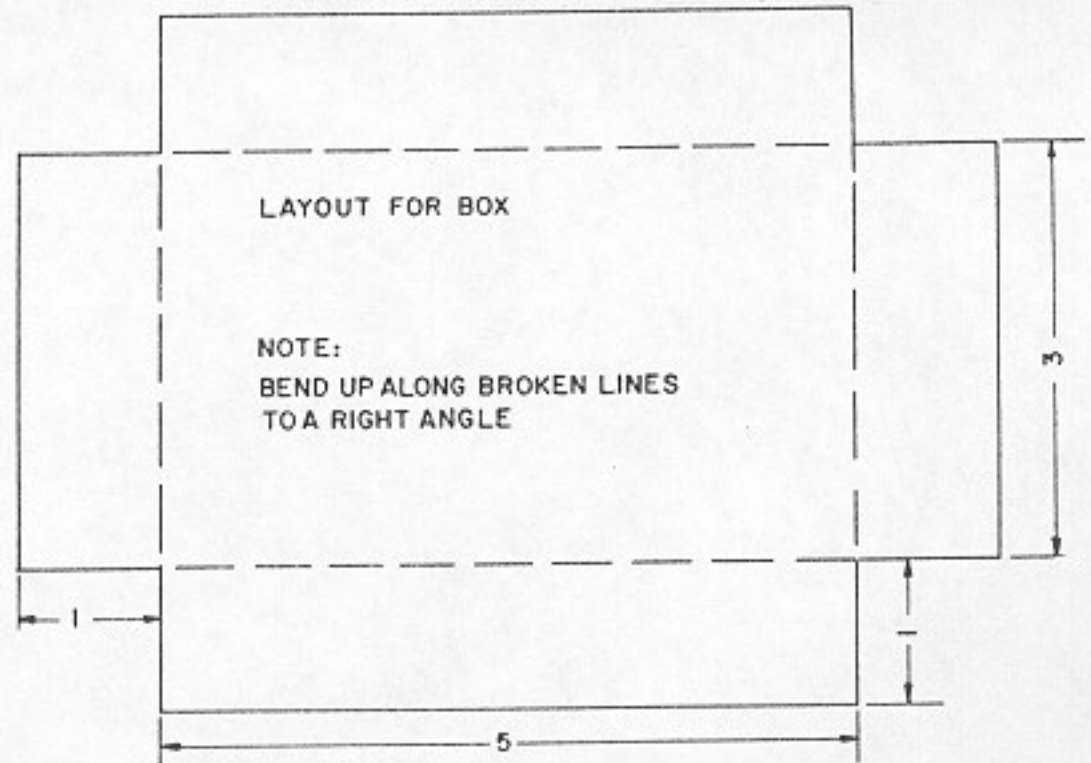
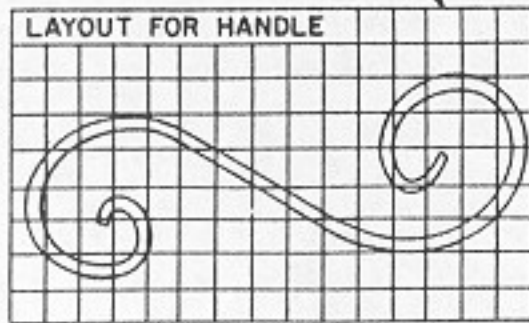
Material

- Box: 1 piece 18-gauge copper or brass, 5" x 7"
 Top: 1 piece 18-gauge copper or brass, 3 7/8" x 5 7/8"
 Handle: 1 piece rod or tubing to match box top, 3/16" diameter by 9 1/2" long



$\frac{1}{4}$ SQUARES

219



220

Magazine Rack

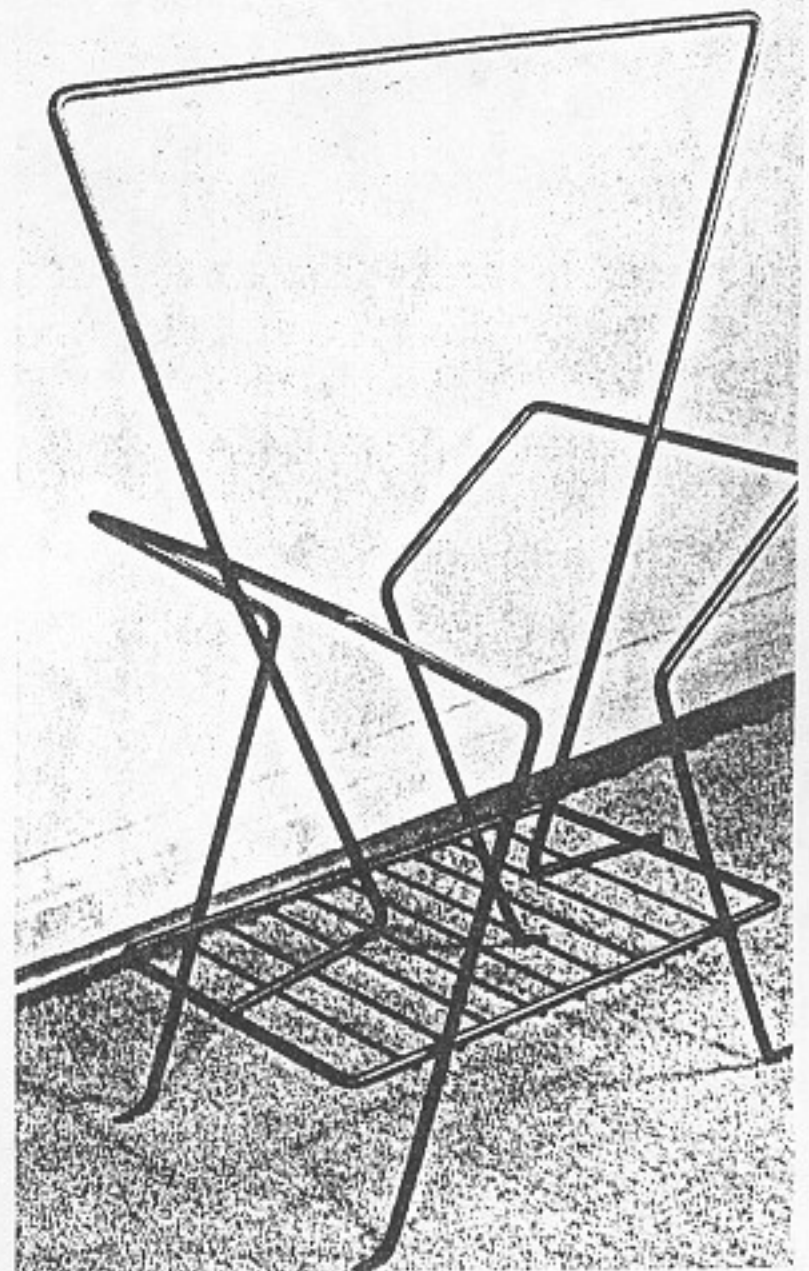
Magazines clutter up a room if there is no convenient place to put them. Such a place can be provided in the form of a magazine rack made of metal rod. Its design is such that it will fit into the furnishings of almost any room.

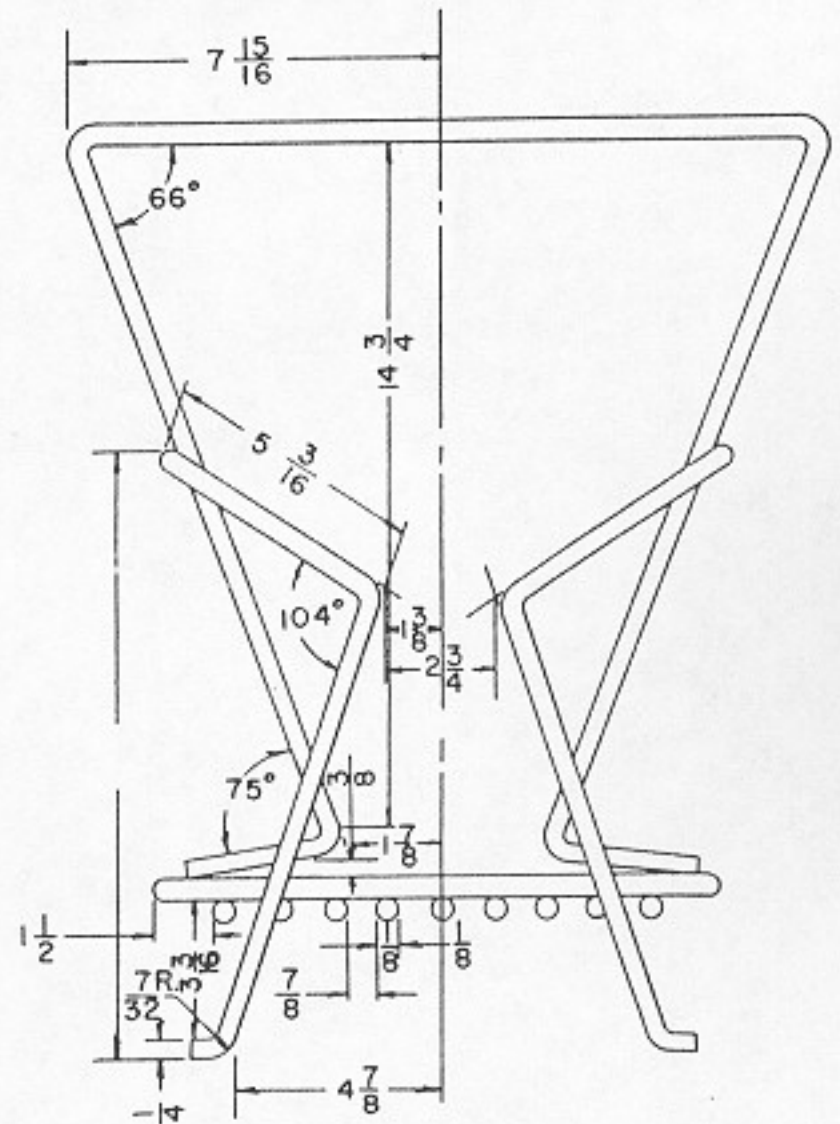
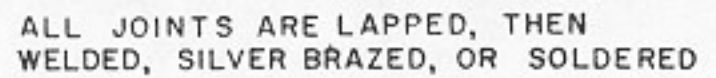
Reference to Operations in Text

Forming and Binding Metal	pages 119, 120
Welding	page 80
Soldering	pages 73-77
Finishing	pages 90 and 103

Material

- 1 piece hot rolled steel, $\frac{1}{2}$ " round by 55" long
- 2 pieces hot rolled steel, $\frac{1}{4}$ " round by 39" long
- 1 piece hot rolled steel, $\frac{3}{16}$ " round by 36" long
- 9 pieces hot rolled steel, $\frac{1}{8}$ " round by $6\frac{3}{4}$ " long





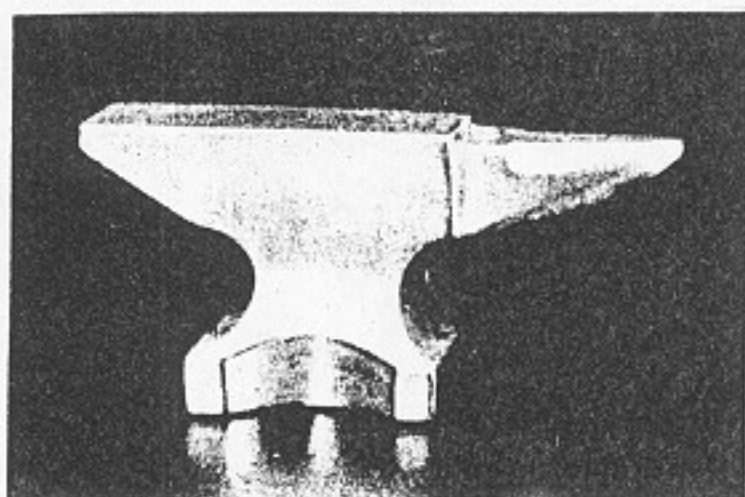
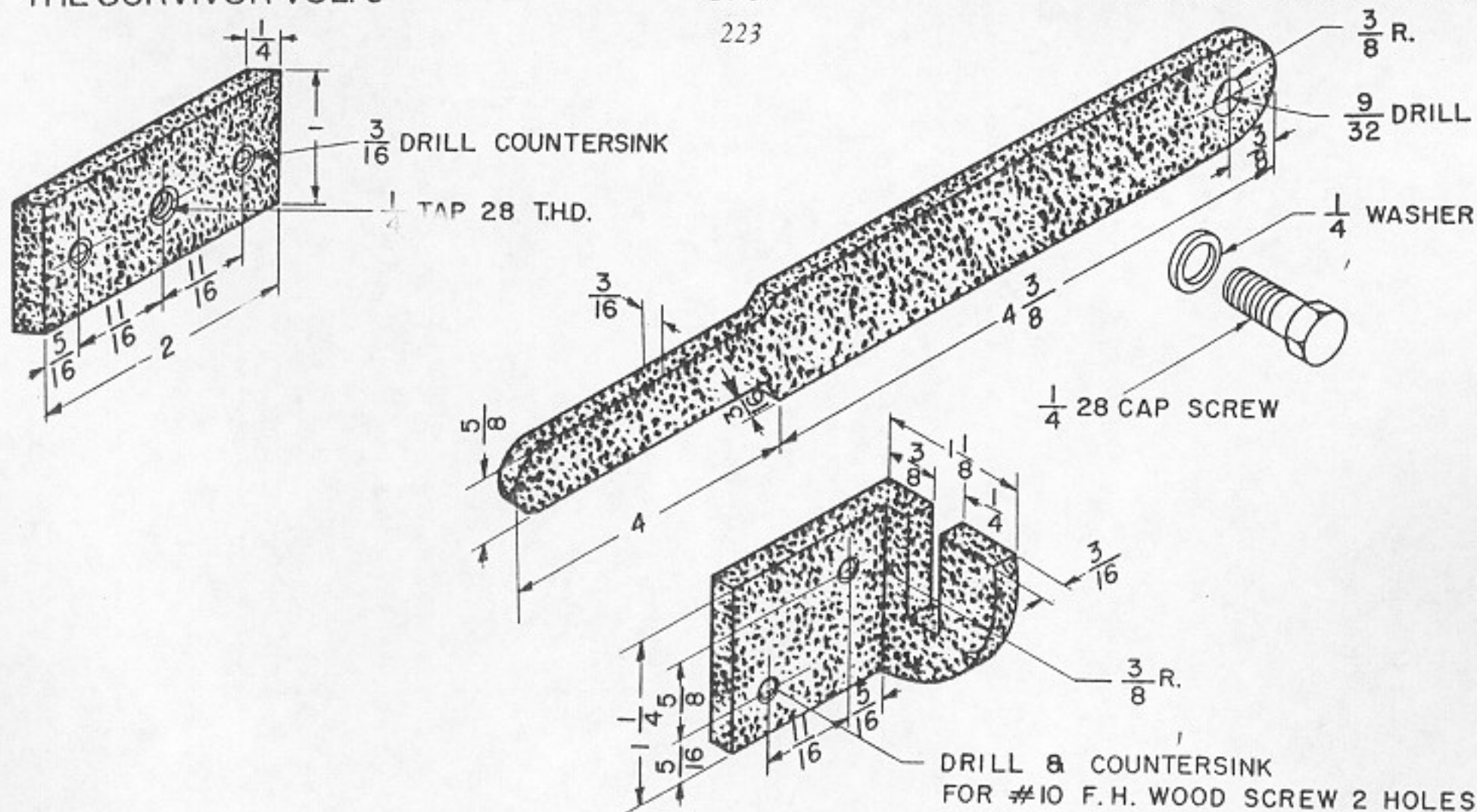
The gate latch has many uses. Both you and your parents will get a lot of use out of it at home. It reminds us of the olden days when the blacksmith made all the hardware. Many backyards are enclosed with fences, most of which have at least two gates that need latches. Then, of course, there is the fruit cellar door or the coal door, if coal is used to heat your home. Don't you think this latch would be fine on the garden gate?

Reference to Operations in Text

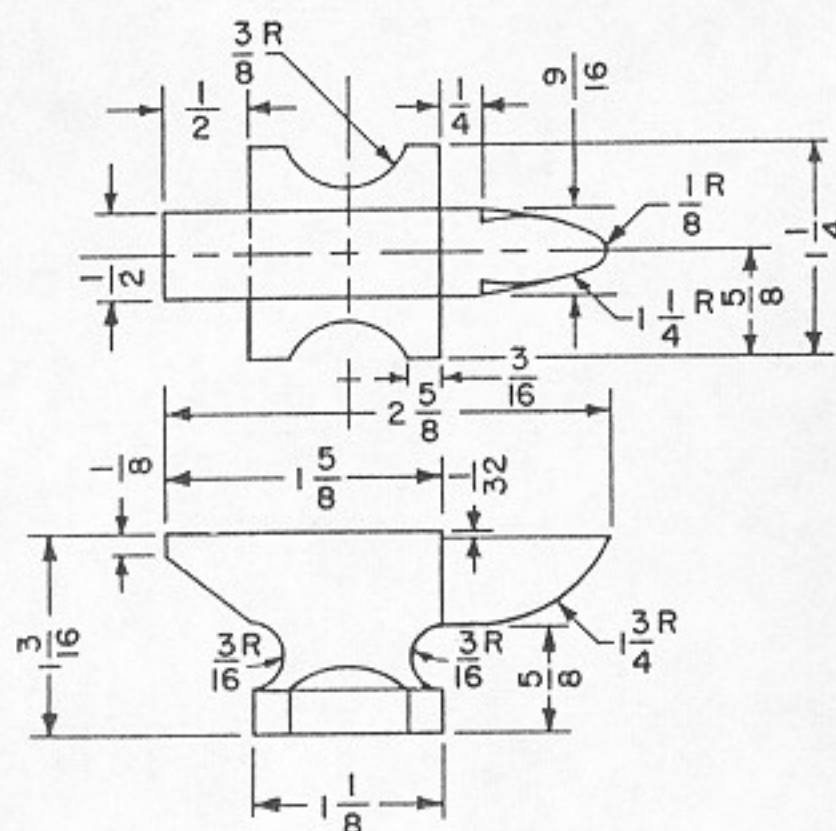
Hack Sawing	page 31
Layout	pages 17-23
Drilling	page 152
Countersinking	page 148
Tapping	page 44
Hammer Marking	page 96
Finishing	pages 90 and 103

Material

- 1 piece hot rolled steel, $\frac{3}{8}$ " x $\frac{3}{4}$ " x $8\frac{1}{2}$ "
1 piece cold rolled steel, $\frac{1}{4}$ " x 1" x 2"
1 piece angle iron, $\frac{3}{8}$ " x $1\frac{1}{2}$ " x $1\frac{1}{2}$ " x $1\frac{1}{4}$ "
1 bolt, $\frac{1}{4}$ " x 28 NF, $\frac{3}{4}$ " long



224



Anvil

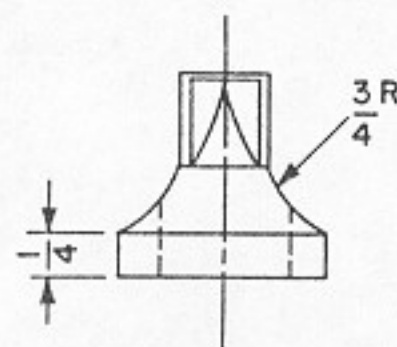
To make an anvil, you must use a pattern that has been made in two pieces. In this case the pattern must be made, for you cannot use another casting for the pattern.

Reference to Operations in Text

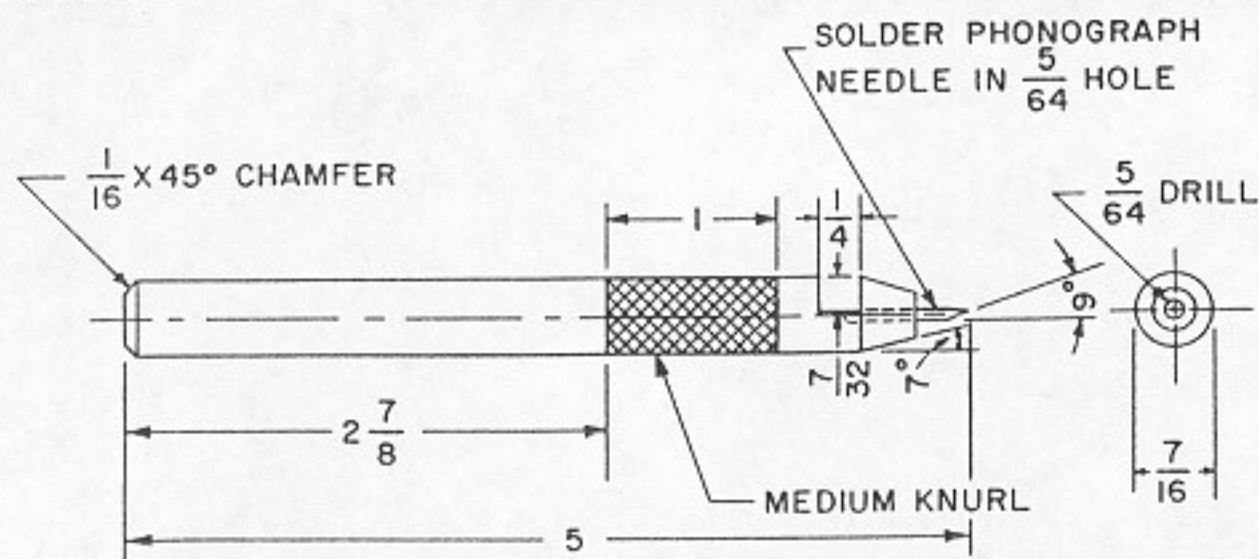
Foundry Sand (Tempering Sand)	page 132
Making a Mold Using a Split Pattern	page 136
Pouring Molten Metal	page 138
Cleaning a Casting	page 140

Material

Scrap cast aluminum or U.S. Reduction Co. aluminum alloy,
#88



Scriber



To draw layout lines on metal, a scriber is used instead of a pencil. The point of the scriber must always be made from hardened steel, and sharp, for otherwise it is difficult to scratch lines into the metal. The suggested scriber can be made with an ordinary phonograph needle for the point. The needle is soldered into the scriber handle. With this type of a scriber, a needle can be replaced at any time.

Reference to Operations in Text

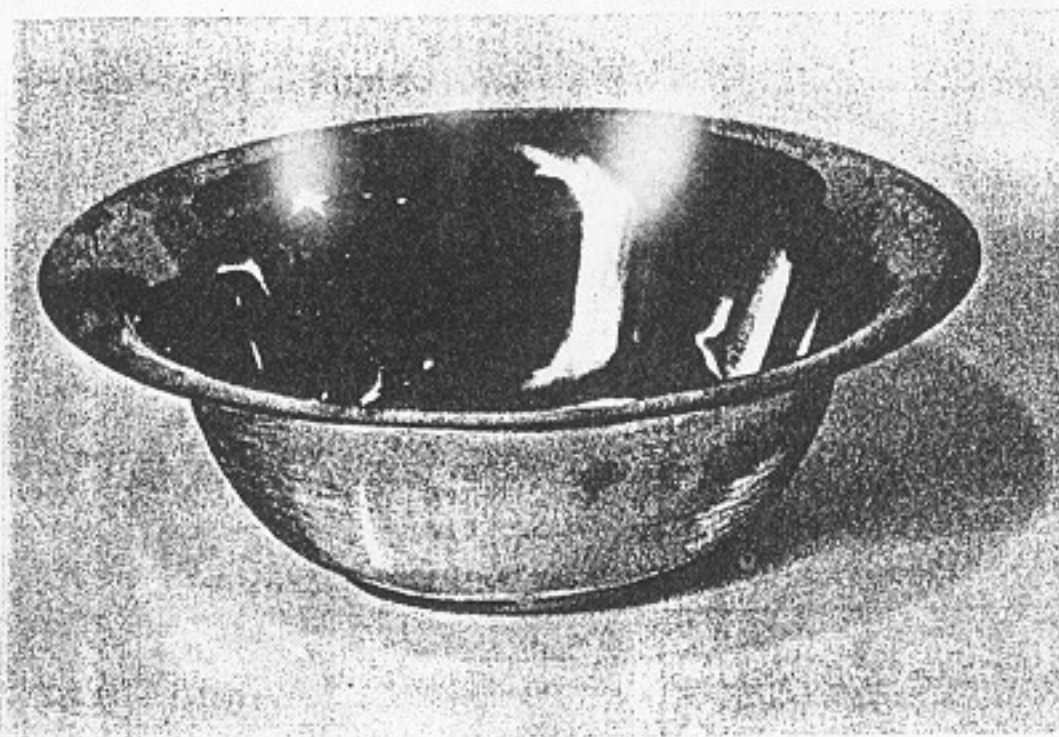
Facing page 160

Drilling Center Holes page 160
 Straight Turning page 163
 Polishing at the Lathe page 168
 Knurling page 169
 Taper Turning pages 166, 167, 168
 Drilling at the Lathe page 169
 Soldering pages 73-77

Material

1 piece cold rolled steel, $\frac{1}{16}$ " diameter by $5\frac{3}{8}$ " long

Nut Bowl



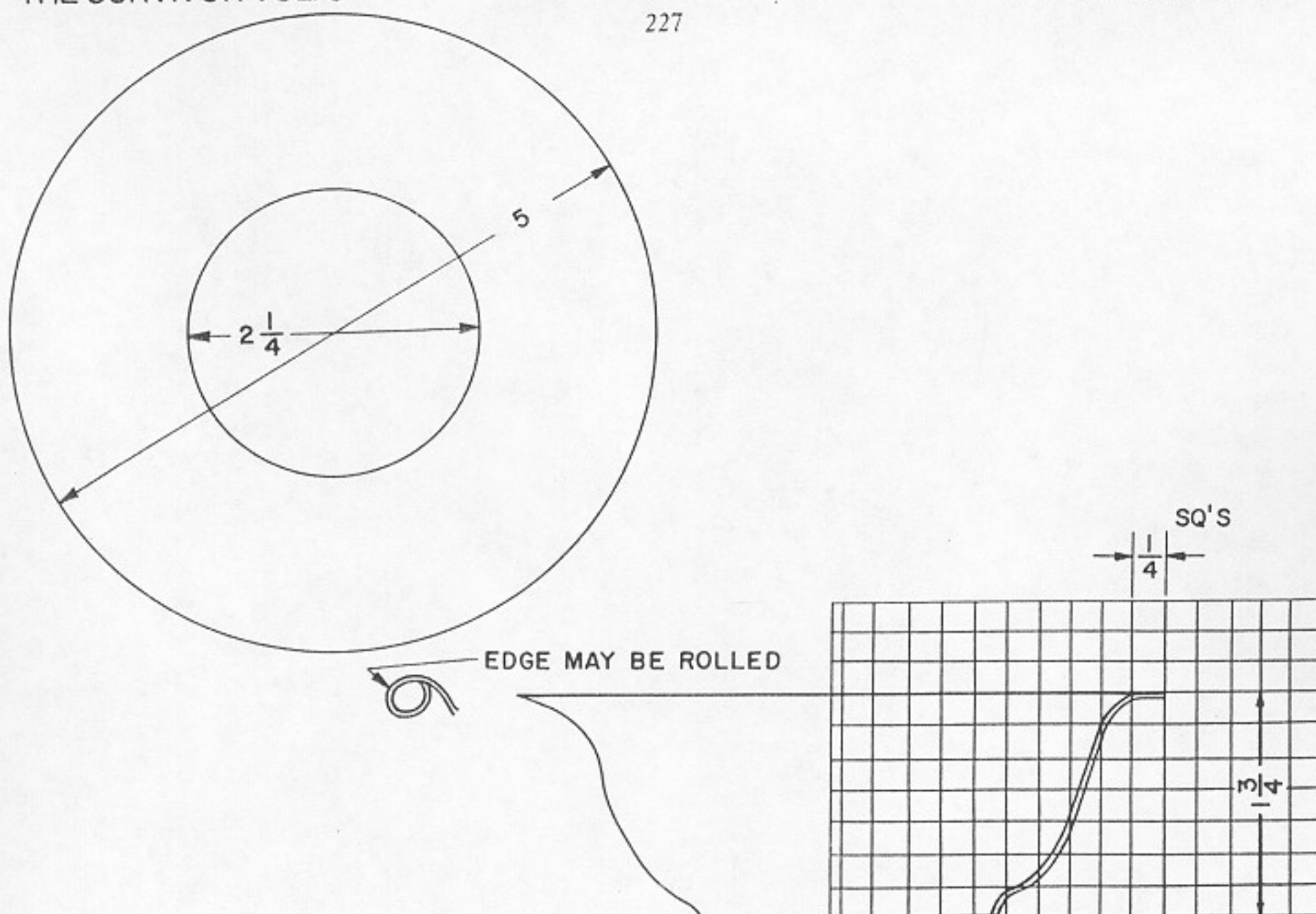
Bowls of this kind can be used in so many ways that it is difficult to give these handy articles a name. However, they are generally referred to as nut bowls or candy dishes. The name comes from how they are used. Usually they are placed on a table in the living room or recreation room, filled with candy, nuts, or something else good to eat. You will find this an interesting project, for the spinning of metal is very fascinating.

Reference to Operations in Text

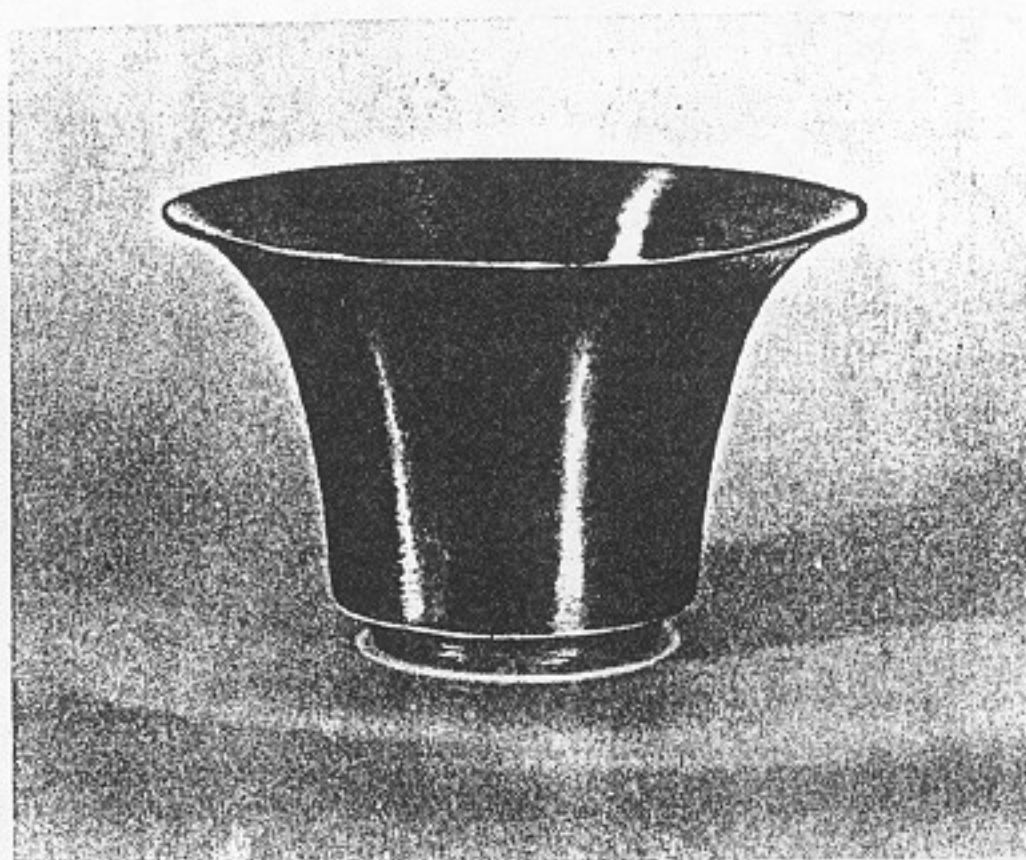
Scribing a Circle page 23
 Cutting Sheet Metal page 36
 Metal Spinning page 105

Material

1 piece 20-gage aluminum, 6" diameter, or 22-gage copper or brass, 6" diameter



228



Spun Flower Pot

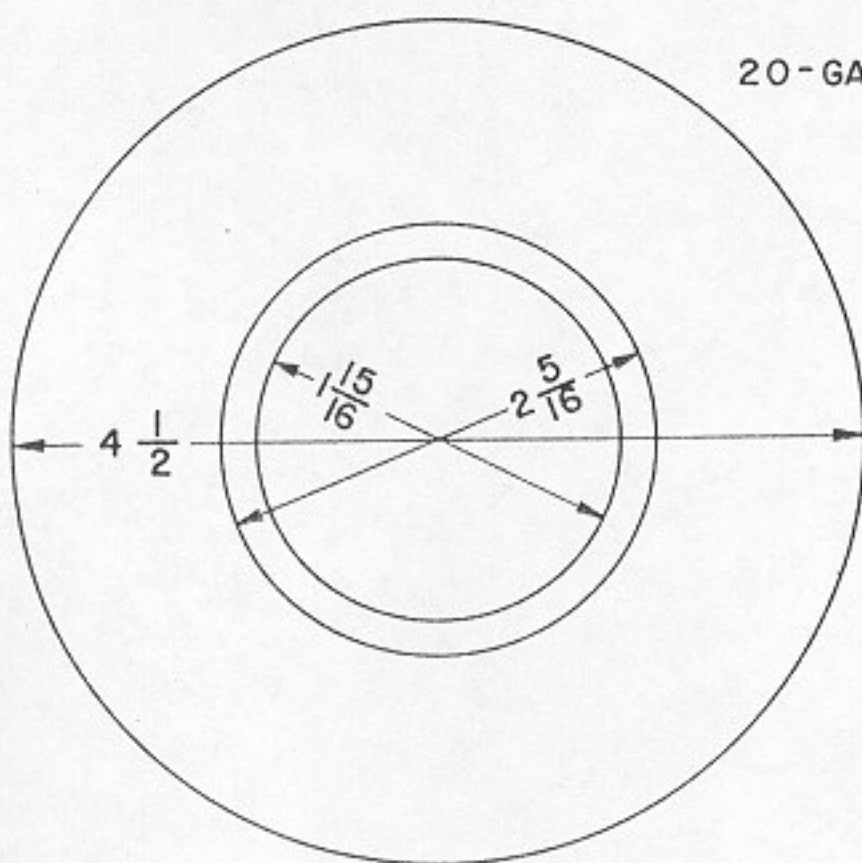
All of us have trouble deciding what to give Mother on Mother's Day or for her birthday. Here is a present that she will cherish. It is beautiful in its very simplicity, and when polished to a high luster it is a real piece of art.

Reference to Operations in Text

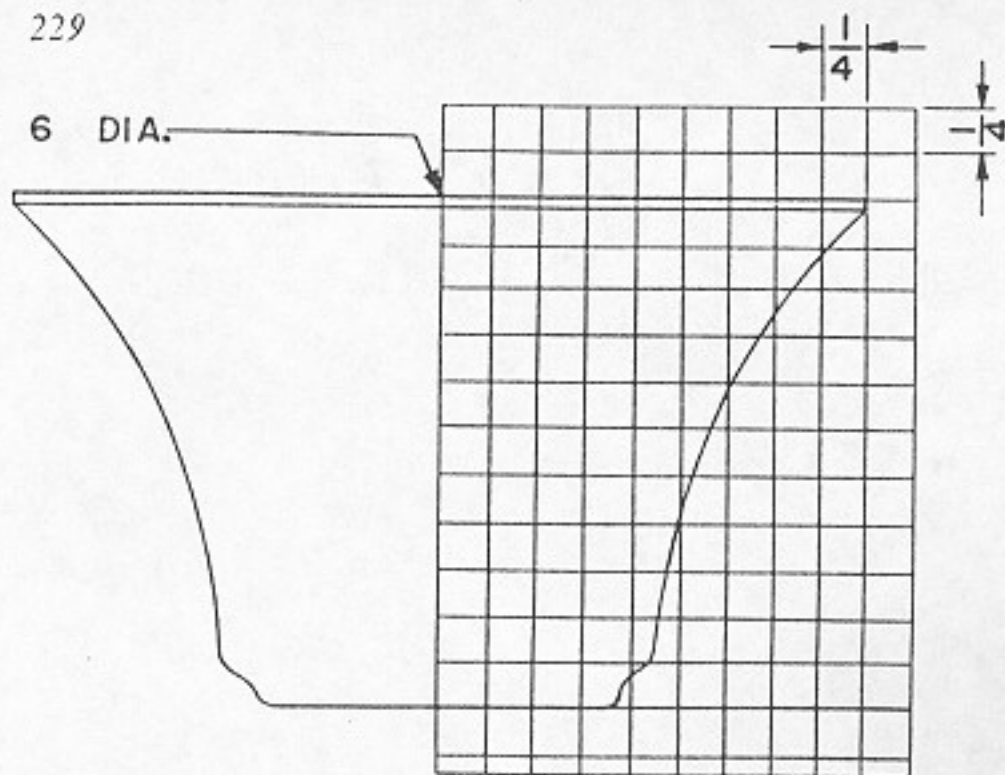
Scribing a Circle	page 23
Cutting Sheet Metal	page 36
Metal Spinning	page 105

Material

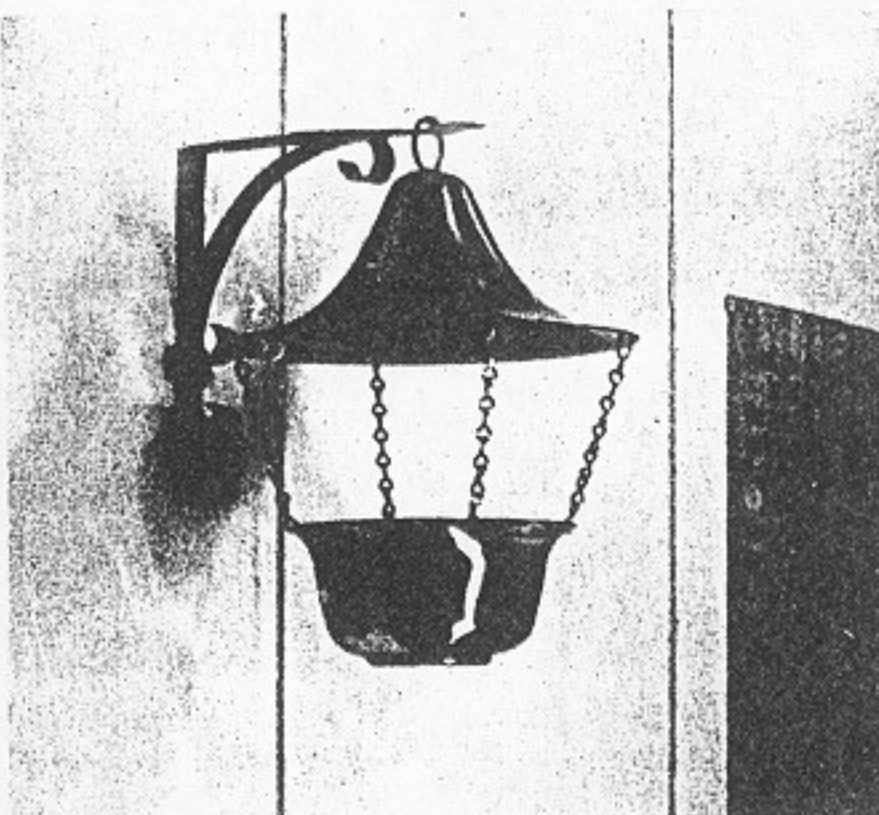
- 1 piece 22-gage copper or brass, $6 \frac{1}{2}$ " diameter, or 20-gage aluminum, $6 \frac{1}{2}$ " diameter



20-GAGE 6 DIA.



Hanging Plant Holder



When properly placed, green plants greatly add to the appearance of a room. To hang them from the wall, pots or brackets of many different shapes and sizes are used. The one suggested here is designed for the hanging type of vine.

Reference to Operations in Text

Cutting Sheet Metal	page 36
Metal Spinning	page 105
Soldering	pages 73-77

Material

Bracket:

- 1 piece 18-gage copper, brass, or aluminum, $\frac{1}{2}$ " x $9\frac{1}{2}$ "
- 1 piece 18-gage copper, brass, or aluminum, $\frac{1}{2}$ " x 7"

Plant Holder:

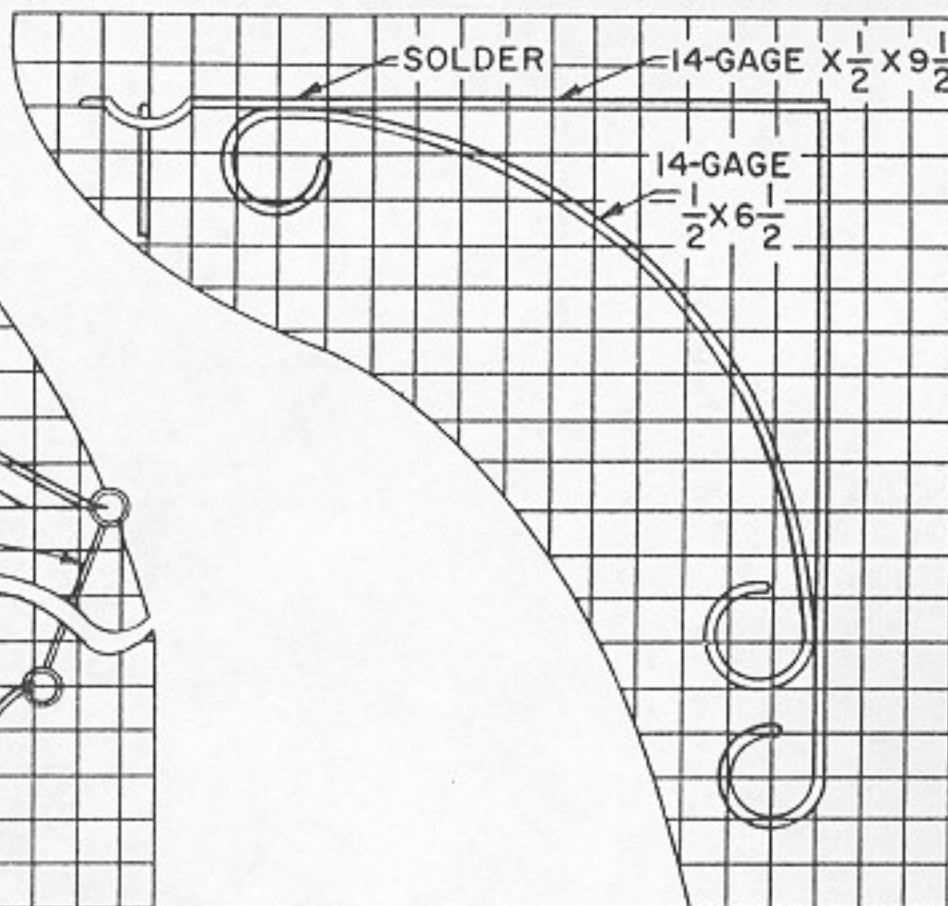
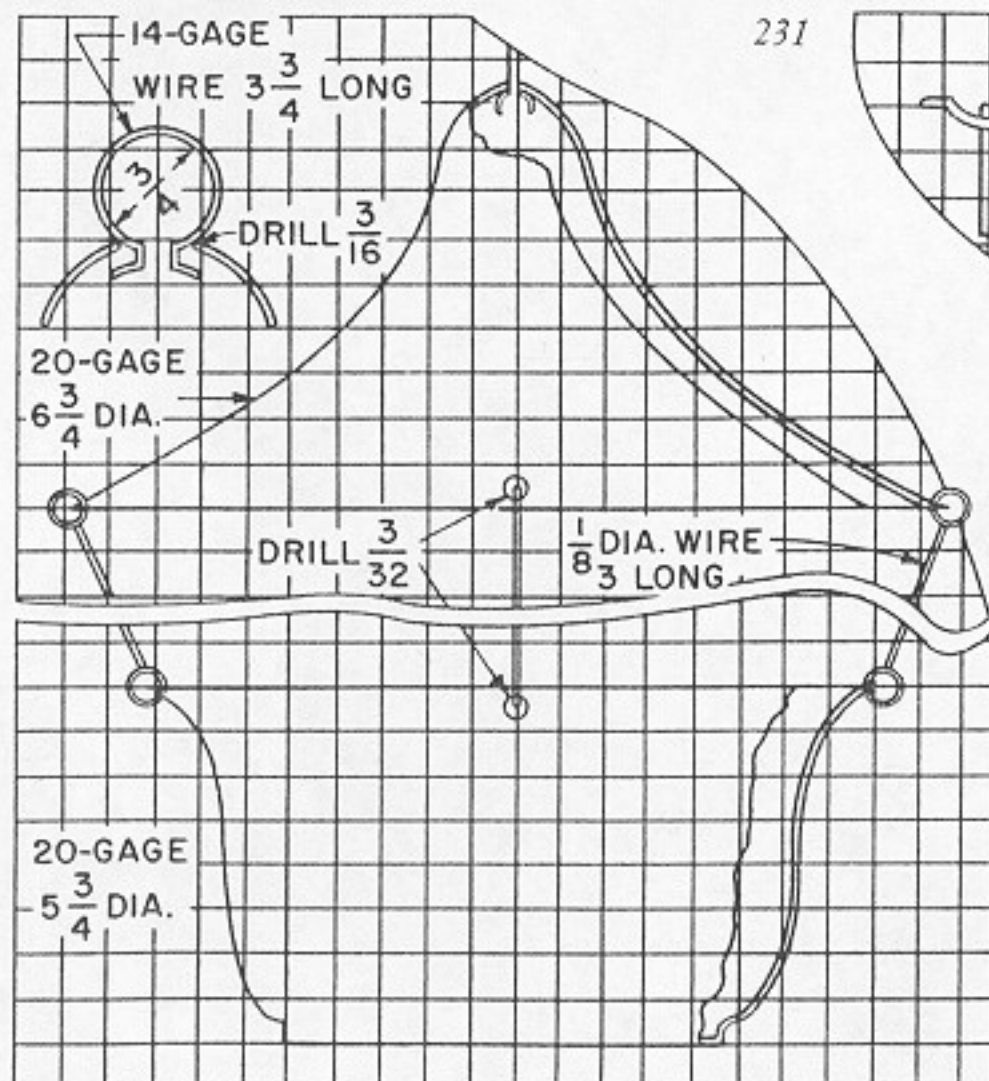
- 1 piece 22-gage copper or brass 5" diameter, or 20-gage aluminum, 5" diameter

Canopy:

- 1 piece 22-gage copper or brass, 6" diameter, or 20-gage aluminum, 6" diameter

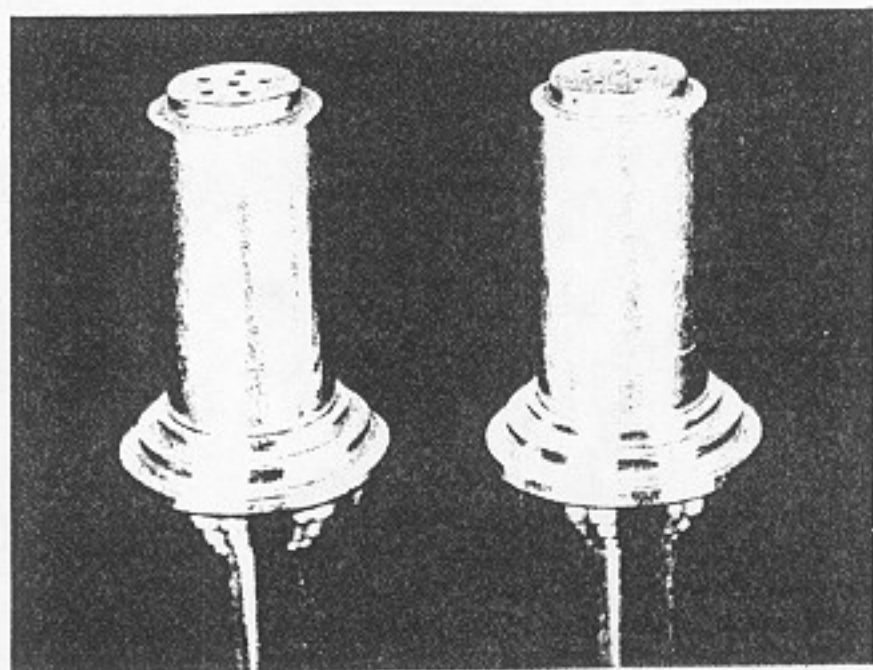
Ring and Wire:

- 1 piece 14-gage wire, $3\frac{1}{4}$ " long, to match canopy
- 4 pieces wire or chain, $3\frac{1}{4}$ " long, to match canopy



232

Salt and Pepper Shakers



Salt and pepper shakers lend themselves to very interesting designs, and seldom are there too many shakers in any home. To try to produce something new and interesting and at the same time practical is a challenge to your ability as a metal-crafter.

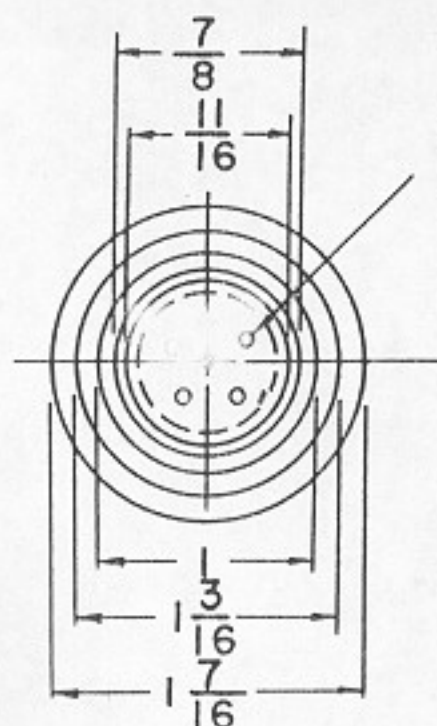
Reference to Operations in Text

Facing	page 160
Turning with a Lathe Chuck	page 159
Shoulder Turning	page 164
Drilling at a Lathe	page 169
Polishing at a Lathe	page 168

Material

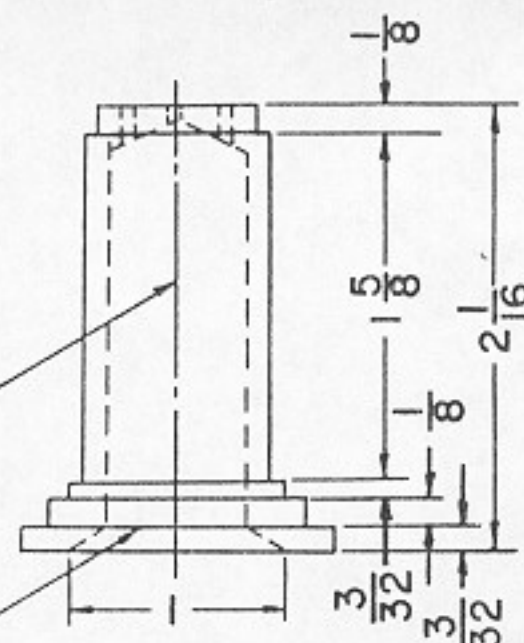
2 pieces aluminum or cold rolled steel if to be chrome plated, $1\frac{1}{2}$ " diameter by $2\frac{3}{4}$ " long

233



DRILL # 53 FOR SALT
60 FOR PEPPER

DRILL $\frac{9}{16}$
2 DEEP



HOLE TO BE SEALED
WITH ADHESIVE TAPE

235

I N D E X

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Harmonograph Fascinates Young and Old

POPULAR MECHANICS

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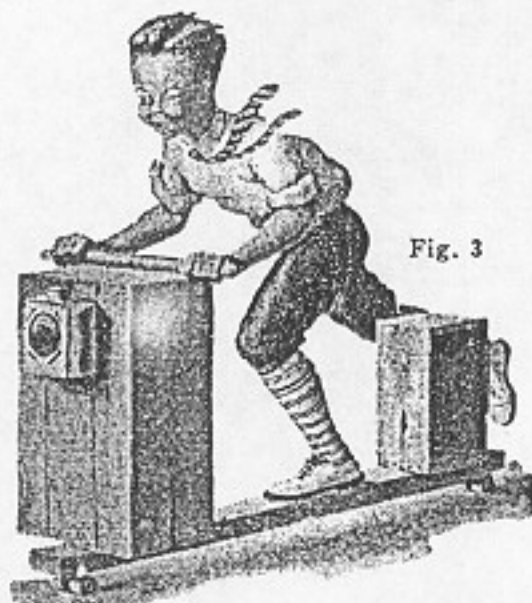


Fig. 3



Fig. 4

THE SKATEMOBILE

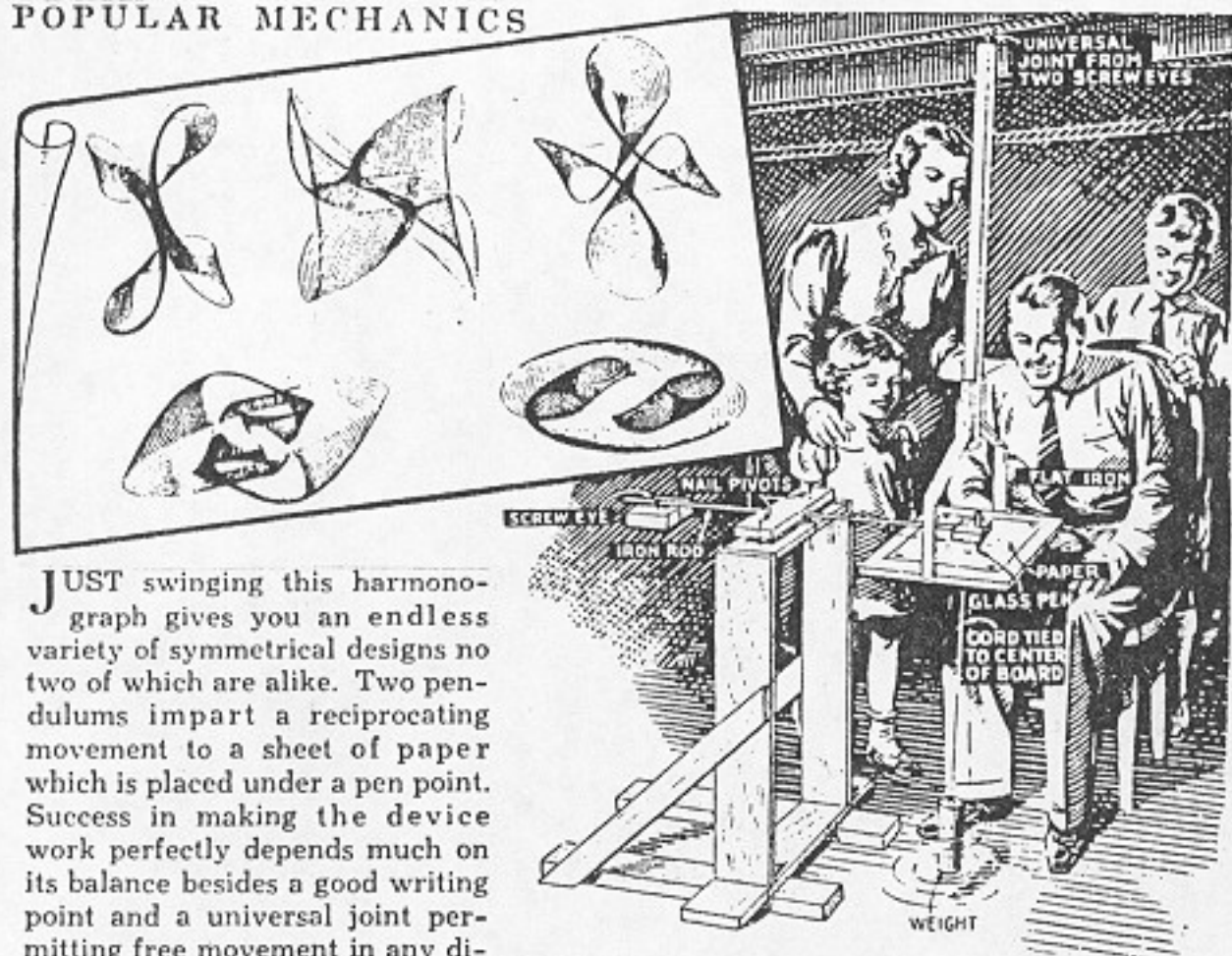
The best platform for the skatemobile in Fig. 3 is a board 4 inches wide, 2 inches thick, and 3 feet long. Separate front and back wheels of a roller skate by loosening nut on the adjusting screw and pulling the frames apart. Clamp toe of skate to front end of running board, and strap heel to rear end of running board. Fasten frame of skate to board with nails (Fig. 4). Nail handle to box and attach box to front end of board. A smaller box at rear makes a seat. A coat or two of bright paint will not be amiss.

HOW TO MAKE A SAIL

In summer and winter, with ice or roller skates, you may use the sail shown in Fig. 6. To an upright support 5 feet long nail two crossbars 3 feet long—all strips to be of wood 1 inch wide and $\frac{3}{4}$ of an inch thick. An old sheet will serve as a sail, and two straps sewn to its sides will make the handles. Your sail will need to be braced by extending a cord from the ends of the crossbars over the ends of the upright support.



Fig. 6

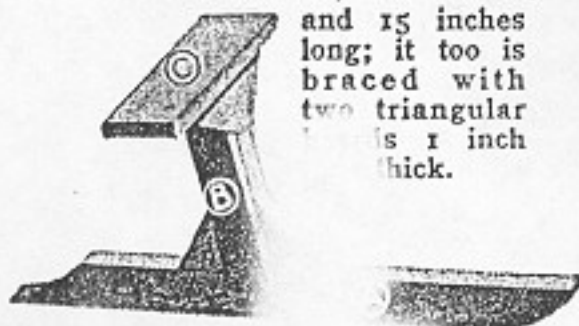


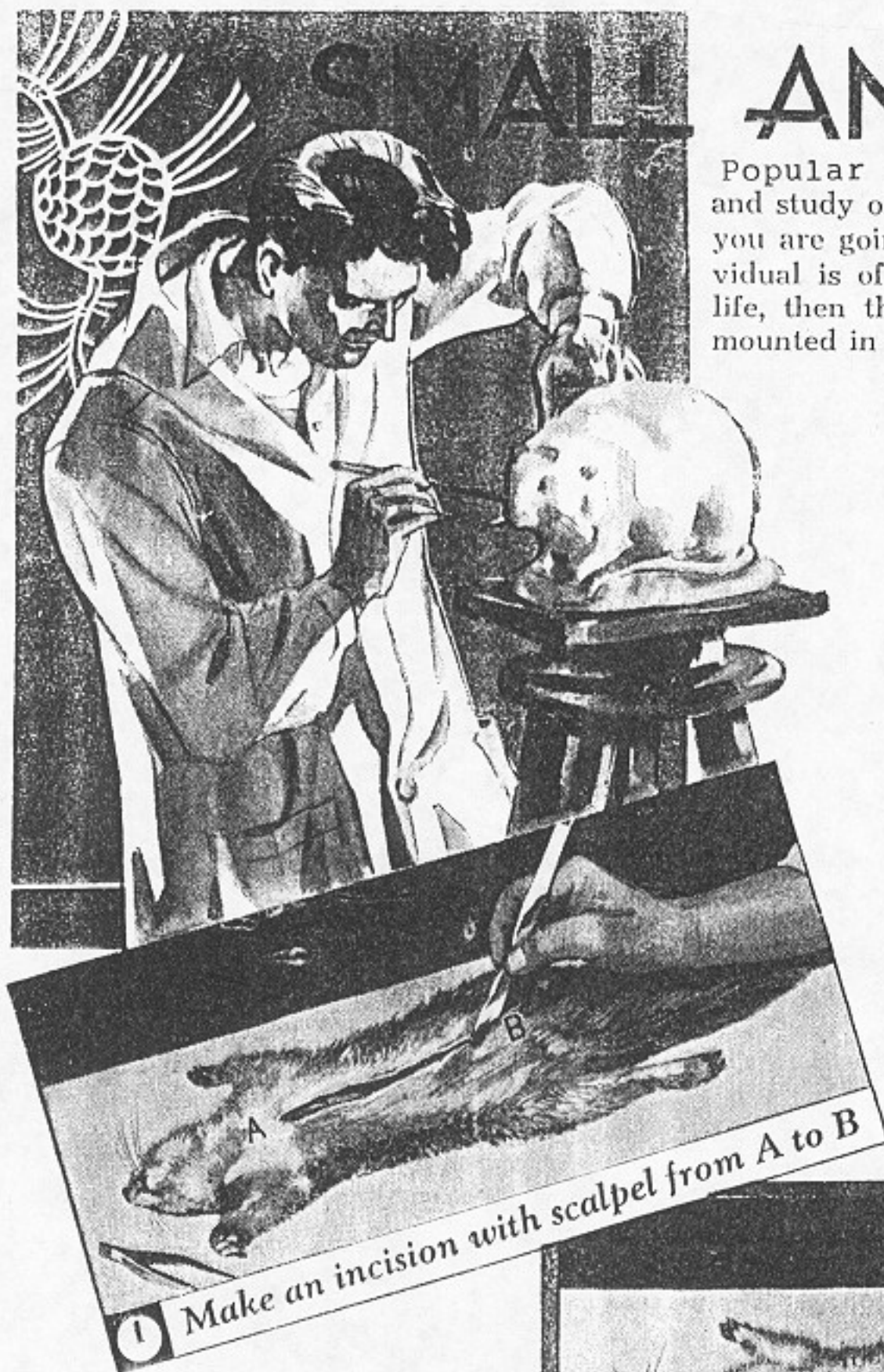
JUST swinging this harmonograph gives you an endless variety of symmetrical designs no two of which are alike. Two pendulums impart a reciprocating movement to a sheet of paper which is placed under a pen point. Success in making the device work perfectly depends much on its balance besides a good writing point and a universal joint permitting free movement in any direction. A long stick is fastened to the ceiling with two screw eyes that form the universal joint. The lower end of the stick is fitted with two flat-iron brackets that hold a writing table on which a sheet of paper is mounted by means of thumbtacks. The stick and table form one pendulum while a cord and weight suspended from the exact center of the table form the second one. To make the writing point you can take a length of glass tubing, heat it and draw out one end to a point through which ink can flow to produce a fine line. Or, you can use a round-pointed writing pen, although this makes coarser lines. The writing point is held on a pivoted arm which is entirely independent of the pen-

dulum, and is adjusted to rest lightly on the paper. Note the method of supporting the arm so that it can move up and down but not sideways, and how the pen pressure on the paper is regulated by means of a sliding counterweight. In using the harmonograph, first set the writing table in motion and then let the pen come down to contact the paper. By making the pendulums move in opposite directions, at right angles to each other, or in any combination of swinging movements, you'll get all kinds of interesting designs.

THE DUTCH JUMPER

The runner (A) of the jolly affair shown below is 3 feet long, 4 inches wide, and 2 inches thick. The upright support for the seat is 13 inches long, 4 inches wide, and 2 inches thick, and is nailed to the runner 6 inches back of the center. Two boards 4 inches wide, three-fourths of an inch thick, and 16 inches long will do for the side pieces (B). The triangular braces on the runner are cut from lumber 2 inches thick, and are 4 inches wide and 4 inches long. The seat (C) is 6 inches wide, 1 inch thick, and 15 inches long; it too is braced with two triangular braces 1 inch thick.





By
John William Moyer

Staff Taxidermist
Field Museum of Natural History



ANIMALS

Popular Mechanics September, 1939
and study of the habits of the animal you are going to mount. If the individual is of a species very active in life, then the specimen should be mounted in such a way as to emphasize some characteristic pose or action.

For the first subject you might choose a squirrel. An animal of this size is easy to skin properly. Although the methods described refer directly to the mounting of a squirrel, any animal, except the larger ones, can be mounted in a like manner. Lay the squirrel on its back, the head pointing to your left and with a scalpel, or a sharp knife, make an incision from A to B as in Fig. 1. Work the skin down each side toward the back, being careful not to cut through the abdomen or

ONE of the first steps in mounting a small animal is to become thoroughly familiar with that particular species in life, that is the anatomy and characteristic poses so that these can be worked accurately and attractively into the mounted specimen. This means some observation

the skin. When you reach the back legs skin each leg down the inside of the foot, Fig. 2, A. When the foot is reached, skin down to the toes, and cut it from the leg but leave the entire foot attached to the skin, Fig. 2, B.

After both back legs have been skinned

MOUNTED

out, separate the skin from around the base of the tail and skin it a part of the way down. Now grasp the part of the tail that is skinned out and firmly but gently pull on the skin until the tail bone pulls loose, Fig. 3, A. It is most important that the entire tail bone be removed.

Skin the carcass down over the back toward the front legs. Do this by gently pulling the skin over the back, using the knife to separate it from the flesh, in much the same manner you would invert a glove in removing it from your hand. When the front legs are reached, skin them down the inside, as was done to the back legs, Fig. 4, A, and leave each foot attached to the skin, Fig. 4, B. Continue the skinning toward the head, being very careful in removing the skin around the ears and eyes that you do not cut through it. When the mouth is reached, continue skinning around the lips until the skin comes loose from the skull, Fig. 5, A. There is no need to remove the ear cartilage in the smaller animals. An important step at this time, is to make a small slit near the tip of the tail, so the preserving solutions can run through it. Wash the skin thor-

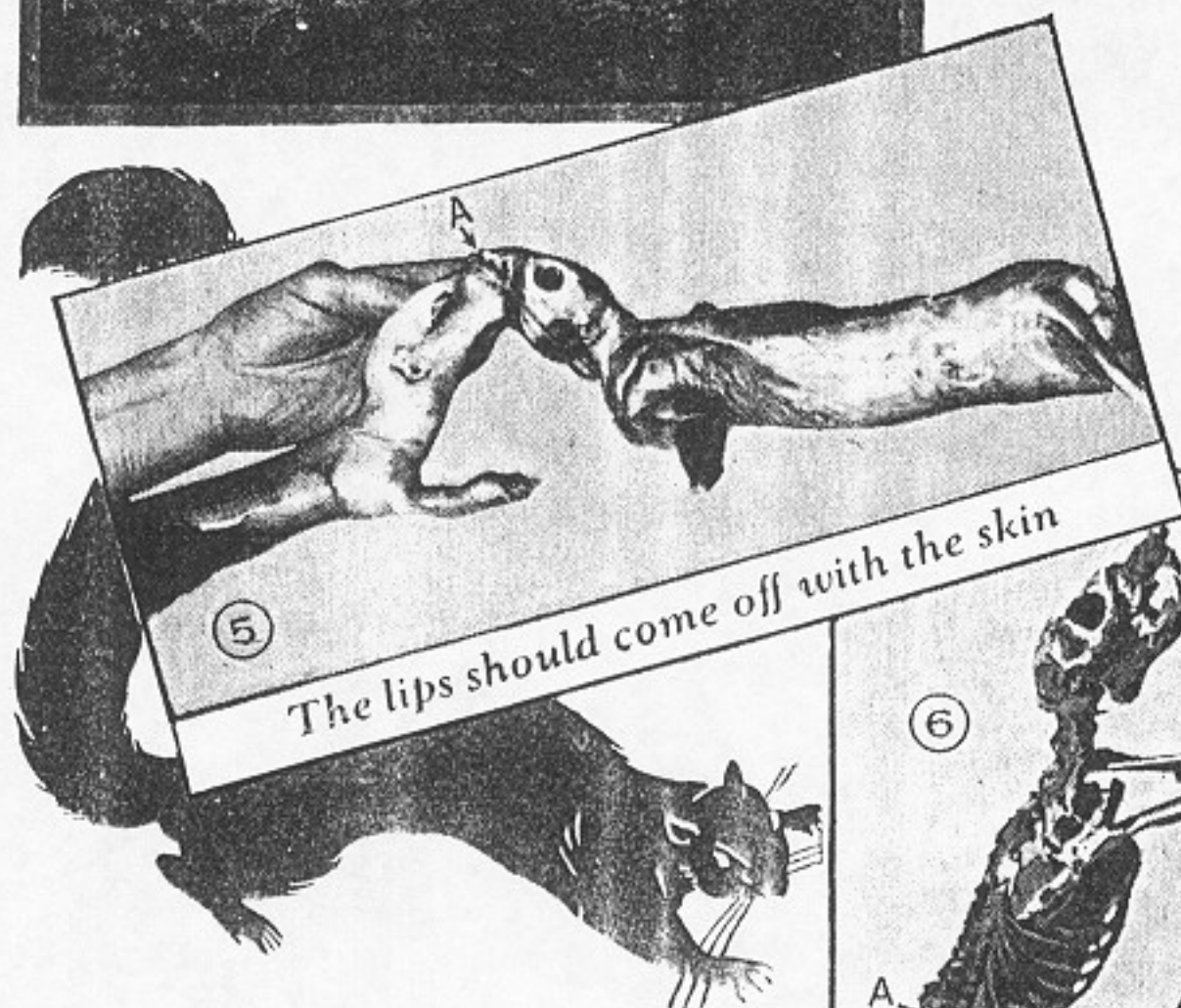




open the lips and nostrils, so they will not shrink in drying.

After the skin has been scraped, turn it right side out, put it back in the alcohol and leave for about two weeks. This tans the skin. When ready to put it on the modeled body, remove from the alcohol, allow to drain well and then immerse it in a saturate solution of borax-water. To make the borax water add carbolic acid, 1 teaspoonful, to water, 1 quart. Then after stirring thoroughly, add all the powdered borax the water will take up. This solution preserves the skin. Allow it to stay in the borax-water for about an hour, remove and hang up to drain.

In mounting by this method, the entire skeleton is used. As soon as the carcass is skinned, remove the intestines and cut away all flesh and muscles. Clean the head thoroughly by removing the brains through a small hole

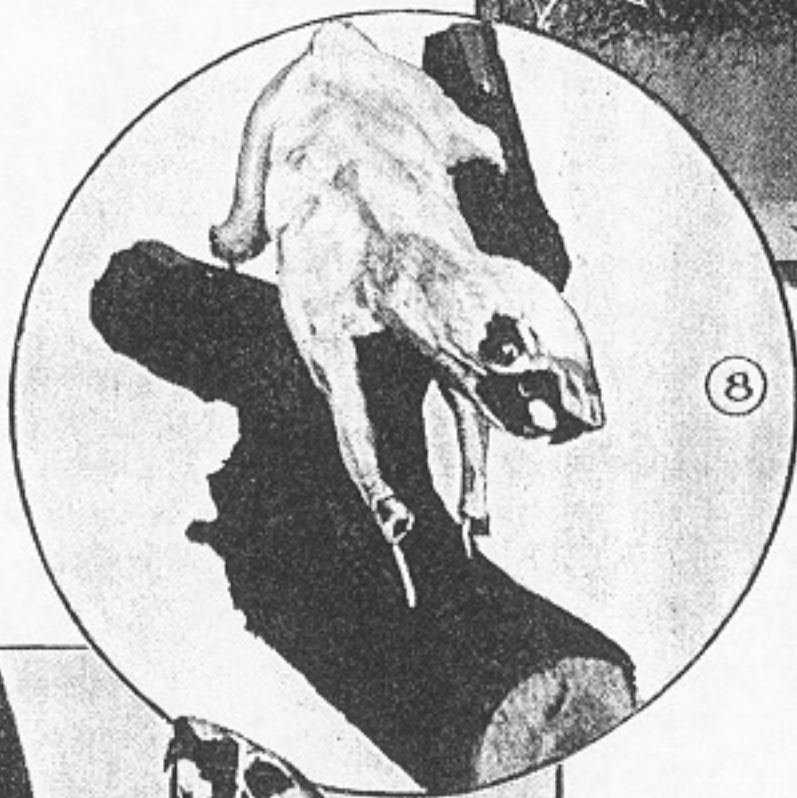


oughly in cold, running water, allow it to drain, then immerse in commercial grain alcohol in a glass container, leaving it in the alcohol for a day. Then remove and with a small scraper, which can be made by filing a few coarse teeth in the blade of a dull knife, scrape off the inner layer of skin which is over the entire flesh side. Be sure to scrape the skin thoroughly so that one can get the proper amount of stretch when mounting. With a sharp knife, shave down the skin around the eyes and split

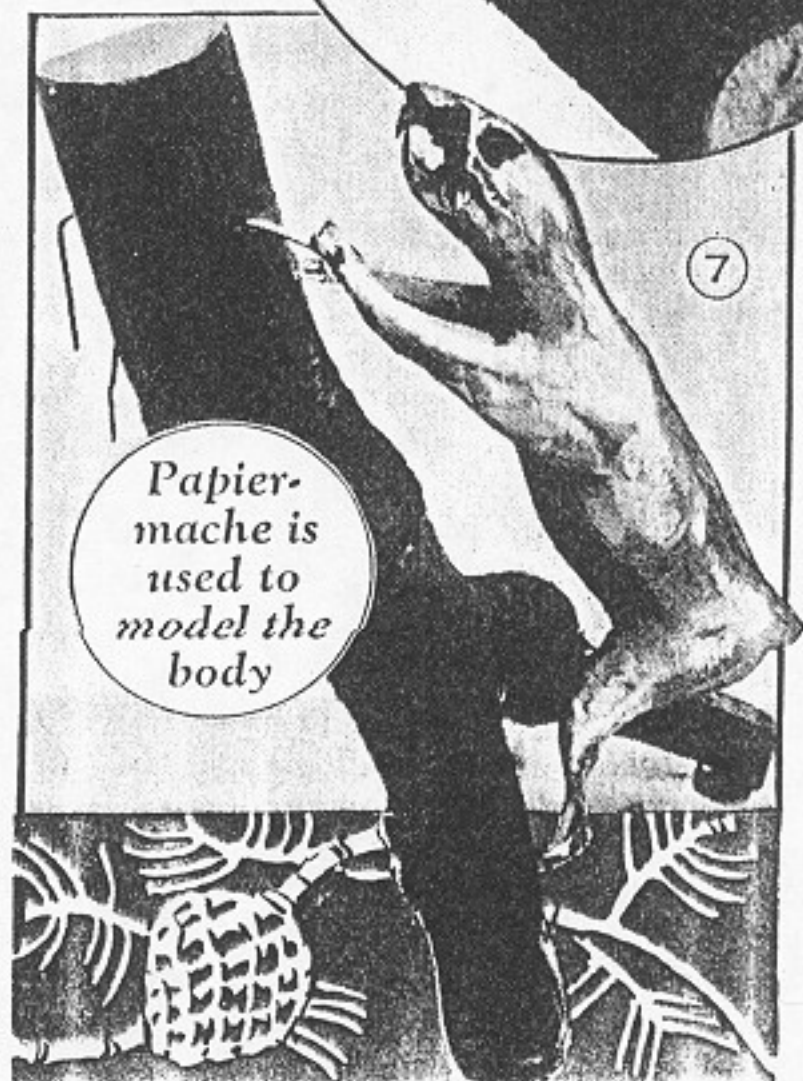


made in the roof of the mouth. Remove the eyes and cut away all the face muscles. The tail can be cut off and discarded after making a notation of the length. Although all the flesh is cut away, do not cut the cartilage and ligaments that hold the bones together, as no part of the skeleton must be separated. When you have the skeleton thoroughly cleaned, wash it in cold, running water. Better still, let it soak in water overnight, then remove and allow to partly dry.

When ready to mount the squir-



8



Papier-mache is used to model the body

7

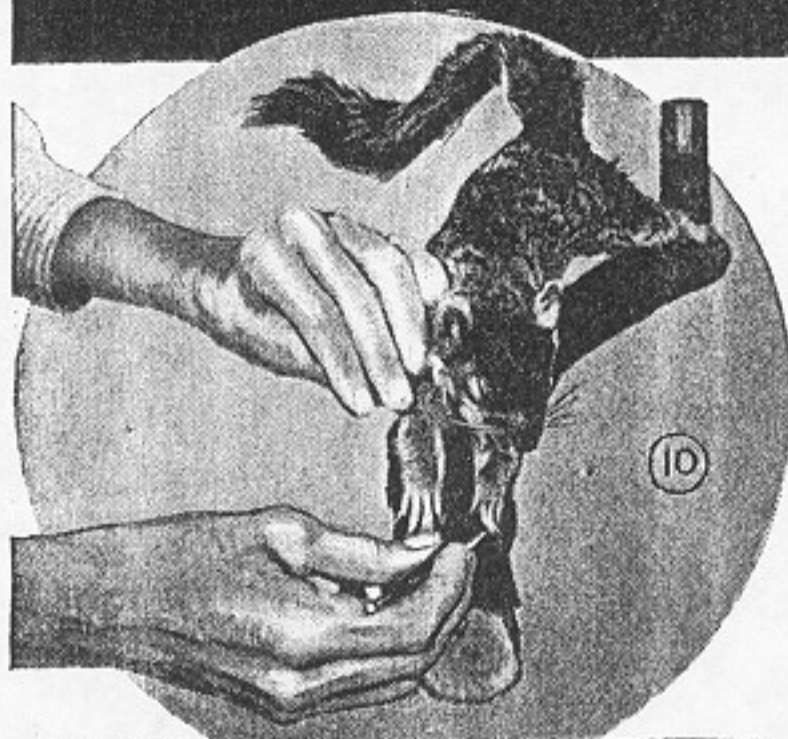
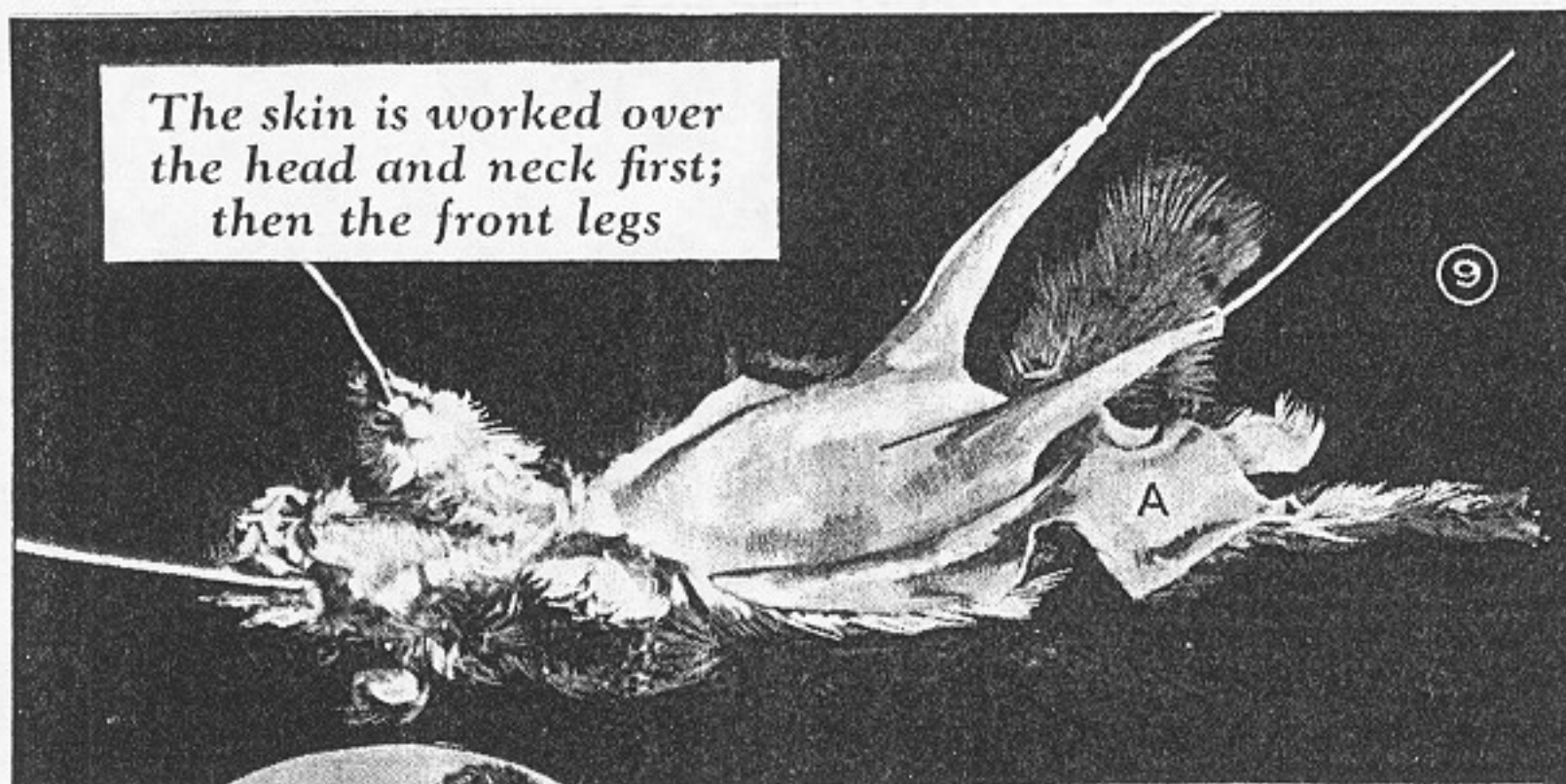
rel, cut the following wires: (larger, or smaller wires are used according to the size of the specimen) four No. 12-gauge wires, sharpened on one end for the legs, one No. 14-gauge wire, sharpened on each end for the head and neck, and one No. 18-gauge wire, tapered to a long point on one end and sharpened on the other. This is

the tail wire. Fit a block of balsa wood into the thorax Fig. 6, A. Make an artificial tail by wrapping very fine tow around the tail wire, starting about 3 in. from the tapered end.

Choose a suitable branch to mount the animal upon and decide now on the pose you want. Shellac the balsa-wood core and then wire the legs, the ends of each wire being forced into the wood core and *wired to the leg bones; Fig. 6, B, B.* The head and neck wire is worked through the top of the skull and fastened into the wood core. The tail is set into place but not fastened. Holes are drilled in the branch to receive the leg wires and the skeleton is shaped and allowed to dry, Fig. 6. While drying, brush it with formaldehyde. This will help to set the bones and will preserve the cartilage and ligaments.

Now, using papier-mache, model over

The skin is worked over the head and neck first; then the front legs



Leg wires should be anchored securely

the skeleton the flesh and muscles that were cut away. Try the skin on occasionally to be sure it fits and see that you are getting the correct contours to the body. Figs. 7 and 8 show the correct anatomy worked out in papier-mache, in the position chosen for the finished mount. Notice that the tail wire has been removed and that the eye sockets and the lip muscles are not as yet modeled in.

After the papier-mache has set, remove the body from the branch. Insert the tail wire into the tail skin and work it well down to the tip of the tail. Mix a small quantity of papier-mache for the eye sockets and lip muscles, but see that this is kept damp so it will not set. Put a small

lump of the mache into each foot and work it well down between the toes. The skin of the squirrel is now pulled over the body. Work the head skin down over the head and neck and the skin of each leg down over the leg. In some specimens the skin of the leg may have to be cut open to get it around the body, Fig. 9, A. Anchor the tail wire to the body and after adjusting the skin in position, begin between the front legs and sew up the incision.

Place the specimen back on the branch and anchor the leg wires in place, Fig. 10. Fit glass eyes, adjusting the eyelids around them. The lips and mouth are shaped and held in position until dry with pins. A small piece of cardboard will hold the ears up and the toes can be fastened to the branch with pins. Smooth the hair and see that no part of it is matted. Set the specimen away to dry for two or three weeks. After drying, the pins and cardboard can be removed. Comb out the hair and "fluff" it up. Brush out the tail, which should be full and bushy. The eyelids and lips can be touched up with black oil paints. In taking specimens for mounting, keep in mind that squirrels and other animals are protected by law in nearly all states. They can be taken legally only during open seasons.

¶ Warm, camphorated oil applied with a soft cloth to white rings on highly polished furniture will remove the stains easily. Rub furniture until dry and polish with another clean, soft cloth.